MAST REPORT REVIEW

Review Prepared by

Thomas Cannon
Consultant

Review Prepared for

California Sportfishing Protection Alliance

Summer 2013

MAST REPORT REVIEW

INTRODUCTION

The following is a scientific peer review of the preliminary draft MAST Report: a draft version of a technical report prepared by the IEP Management, Analysis, and Synthesis Team (MAST) on the subject of "*An updated conceptual model for delta smelt: our evolving understanding of an estuarine fish*." *This draft report is distributed solely for purposes of scientific peer review and review by IEP agency managers. 13*

"The continued existence of the species is dependent upon its ability to successfully grow, develop, and survive in the SFE." (363)

"The conflicts between measures intended to protect and recover the species and actions to provide water and other natural resources to humans have resulted in repeated attempts to reconcile these seemingly irreconcilable objectives." (373)

Why is the MAST Report important? The reason is that this a critical historical period when understanding the estuary ecosystem is essential. The life history and ecology of the delta smelt, other species, and their habitats are important in understanding how the Bay Delta Conservation Plan's (BDCP) proposed changes to water infrastructure will affect the Delta and San Francisco Bay Estuary (SFE).

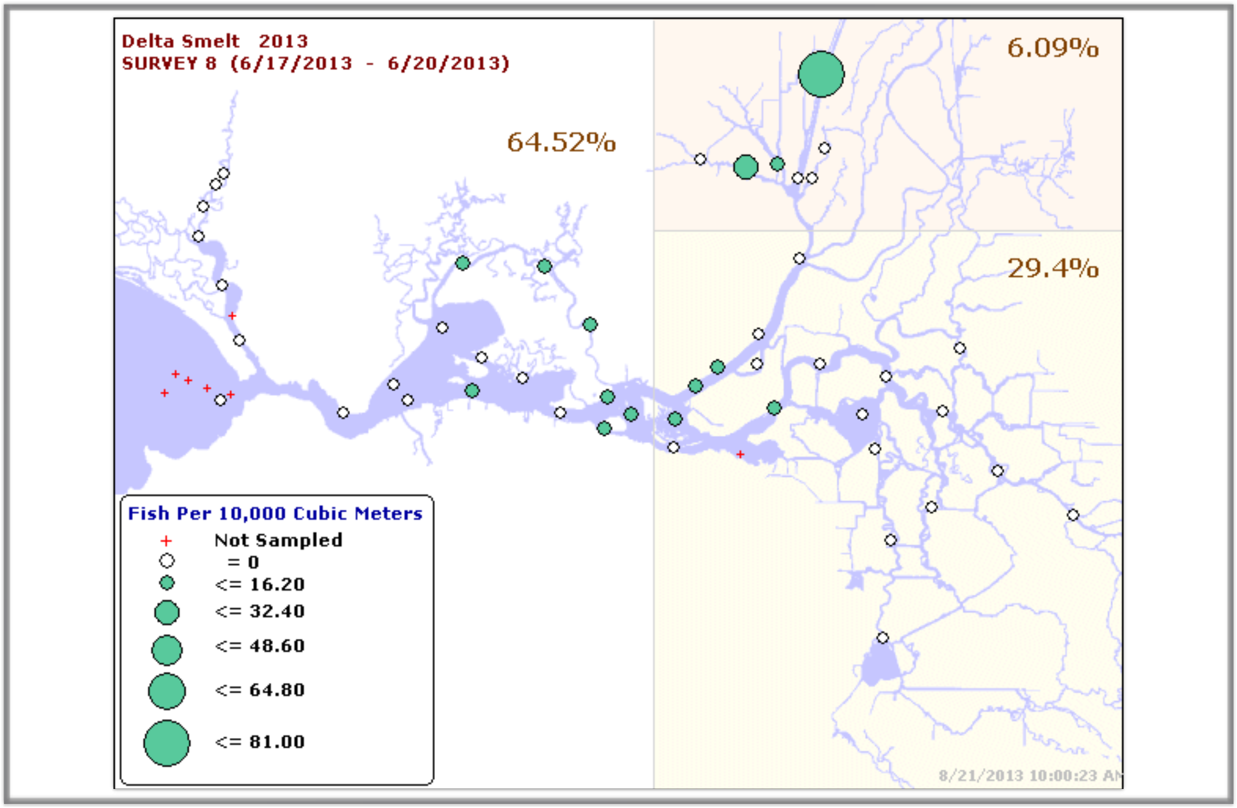


Figure 1. The distribution of delta smelt in 20-mm survey in mid June 2013.

Summer 2013 Example

In this review of the MAST Report, I often refer to the Summer 2013 example to make specific points. In mid June 2013 the small remnant population of delta smelt surviving in the San Francisco Bay-Delta was spread through its usual dry-year, low-salinity-zone habitat in the western Delta, eastern Suisun Bay, Montezuma Slough, and the Cache Slough/Bypass/Ship Channel complex in the north Delta (Figure 1). Other than the north Delta group, most of the smelt were in their summer low-salinity "X2" home where salinities are low (0.5-6 ppt) and water temperature optimal (about 20C). Exports from the South Delta were 2000-3000 cfs (low), Delta outflow was 7,500 cfs, and Old-Middle-River net flows were -2,500. But things were soon to change. How the MAST deals with these changes in Delta standards from spring to summer is of critical importance and the main subject of my review.

I generally ignore the North Delta smelt group because they have their own problems (and solutions) and seem to die out by late summer. The North Delta smelt group residing in the lower Yolo Bypass and Sacramento Ship Channel are attracted and retained by warmer winter waters, higher turbidities, long residence times, high productivities, high nutrient levels, high plankton densities, and higher EC characteristic of that area. The Cache Slough/Bypass/Ship Channel complex can also be a trap with high water diversions and little freshwater inflow especially in spring and summer of drier years. Water is actually drawn from the Sacramento River to meet demands. "*Most delta smelt complete the majority of their life cycle in the low salinity zone (LSZ) of the upper estuary and use the freshwater portions of the upper estuary primarily for spawning and rearing of larval and early post-larval fish.*" (357)

The major Delta story I began above is a perfect example of the "*irreconcilable objectives*". Year 2013 being classified a "Dry Year" with hardly any precipitation in the Central Valley watershed after December allowed for little water exports from the Delta through spring. Only about a thousand smelt were "salvaged" at the export facilities of the CVP and SWP through mid-June because exports were kept to a minimum (Figure 2).

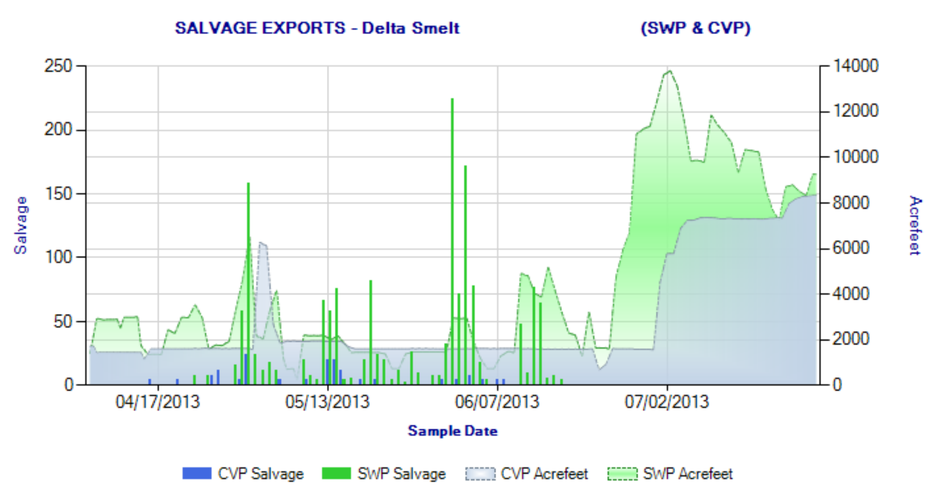


Figure 2. Delta smelt salvage and exports April through July 2013. (Source: http://www.dfg.ca.gov/delta/apps/salvage/)

Though not considered a high salvage of smelt, being only the tip of the iceberg for the actual number killed (salvage is grossly ineffective) the number involved represented major concern for the remnant, nearly extinct population. Given their low initial abundance after last year's poor production, the apparent low salvage may have also represented what was the demise of most of the population given their vulnerability to the export pumps at the time (May and June).

The apparent lack of smelt in salvage by late June 2013 and a false sense of security that smelt are not vulnerable to summer exports[1] led operations managers to simply go ahead and "pump like hell" starting in July. In fact, permission for relaxing the Delta salinity standards after June 15 was agreed to by the resource agencies in late May:

"The change in EC standard at these stations would occur immediately and last through August 15, 2013. The Service supports implementation of the proposal on a one-time basis, so long as implementation does not affect management of OMR flow to protect juvenile delta smelt in accordance with the Service's 2008 OCAP Biological Opinion. It is our understanding that some discussions related to possible changes in Delta outflow have yet to occur. We will evaluate proposals related to deviations from the D-1641 Delta outflow standards when/if they are proposed." (USFWS letter, 5/28/13)

So why did the Service (a key member of MAST) support relaxing water quality and flow standards that are provided to protect delta smelt and their Delta habitats? Why did they allow salinities and water temperatures to climb in the central Delta after June 15 (Figure 3)? Did they have no idea as to the vulnerability of the smelt or their critical habitat? Or that the salinity relaxations would be brought about by reducing outflow and maintaining high exports? Were they expecting to see a surge in smelt salvage to warn against an impending disaster (after it was too late)? Did they breath a huge sigh of relief when no surge occurred? Did they know that no smelt could have made it alive to the State salvage facilities in Clifton Court Forebay under these conditions? Was this an "adaptive management experiment" to see how far they could go with such relaxations?

---

[1] The OCAP BO for smelt drops OMR protections for smelt after June and the Smelt Working Group recesses for the summer.

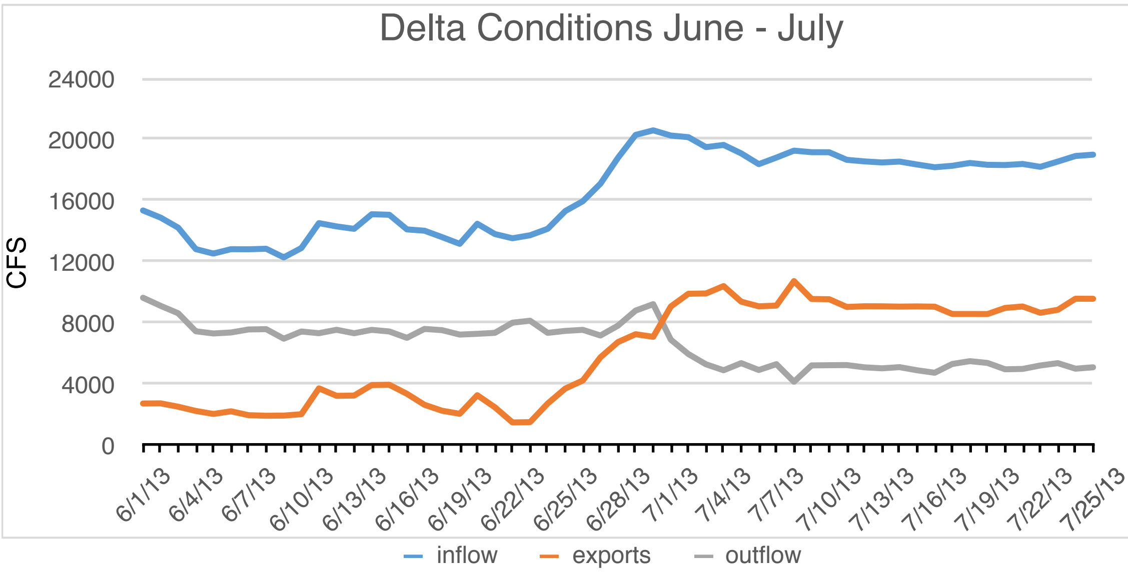


Figure 3. Delta inflow, outflow, and exports in June and July 2013.

In a dry year classification like 2013, the key D-1641 Delta standards after June 15 are:

- Delta outflow of 5,000 cfs
- EC maximums at Emmaton and Jersey Point

The OCAP SMELT BO has a further restriction on OMR flow through June.

So how does the MAST deal with changes allowed under these limited restrictions on water project operations? They start by telling us there has been a major ecological regime change over the past decade that has caused a Pelagic Organism Decline or POD (they do not even mention water project operations). I could find only one change that could cause the POD: the 1995 D-1641 standards allow for unlimited summer exports under low outflows, as exemplified in the above chart (Figure 3) after mid June, and the associated major trauma put on the Delta from the combination of high inflows, low outflow, and high exports.

Ecological Regime Shift

"Moyle and Bennett (2008) and Baxter et al. (2010) suggested that the SFE, particularly the Sacramento-San Joaquin Delta (Delta, fig. 2) has undergone an ecological regime shift". (391)

This so-called "*regime shift*" was actually caused by the export of the spring-summer "Pelagic Habitat" of the Delta each year since the D-1641 standards were first initiated in 1996. The POD did not occur until the first sequence of dry years after D-1641 in 2001-2002[2], when the consequence of such reckless water management in Delta became apparent with the allowance of unlimited summer exports under low Delta outflows. Though a mystery to some, the POD and the disaster wrought by D-1641 were not a mystery to many long-term Delta veterans who had tried to manage Delta ecology with June-July standards for nearly two decades prior to D-1641 with D-1485. This summer, 2013, the ugly head of D-1641 again reared its head only to be further exasperated by the proposed "relaxation" of already lax D-1641 dry-year standards (objectives) that if implemented could have even further led to the near extermination of the smelt. (Note: the "relaxation" would have allowed reduction in outflow to 4,000 cfs and higher salinities at Emmaton and Jersey Point.)

"Current management of water for agricultural, industrial and urban purposes is focused on stabilizing flow and salinity regimes to optimize water exports by the federal Central Valley Project (CVP) and State Water Project (SWP)." (400). Current management is focused on exporting 20,000 ac-ft per day or more during the summer (and as much as possible during the rest of the year). This management feature in D-1641 has allowed the export of over 6 MAF per year from the Delta with 0.6 MAF or more during each summer month. These are the cause of the "regime shift". You simply have to look at Figure 3 above to see the mechanisms.

[2] water year designations: http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST

MAST Key Questions

The following are key questions put forth by the MAST

1) Why did delta smelt abundance increase in the wet year of 2011? 432

2) Why did delta smelt fail to respond to wet conditions in 2006? 433

3) Why did the strong year class of delta smelt produced in 2011 fail to produce a large number of adult fish in the following year class of delta smelt? 434

A further underlying theme of this review is how smelt are faring in 2013 and whether the MAST conceptual model (CM) predicts the specific circumstances, species response, and outcomes.

MAST Conceptual Model

The conceptual model will help in: "*organizing, analyzing, synthesizing, and communicating results about delta smelt responses to changing habitat conditions.*" 443

So, is the model helpful in determining what happened after June 15 this summer? In short, No! The model does not predict the response of D-1641 standards, OMR constraints in the OCAP BO, or the proposed relaxation of Dry Year Salinity Standards of D-1641.

What the model is missing is an ability to conduct a real time synthesis of the myriad of daily survey data available to resource managers. There are IEP surveys as well as extensive arrays of WQ monitoring stations throughout the Delta that provide abundant real-time information for real-time synthesis to determine effects of project operations.

"*Fall outflow management is currently the only active adaptive management aimed primarily at benefiting delta smelt while also protecting water supply*." 452 This statement seems incredible given the almost continuous sequence of adaptive management going on with reservoir operations, water diversions, and Delta exports, coincident with an unprecedented amount of environmental data collection. The end of June 2013 is a major "experiment". The end of VAMP and the Delta without VAMP in the past three years are certainly experiments.

The proposed "experiment" of relaxing summer salinity restrictions at Emmaton and Jersey Point that would allow reduction in outflow should also be considered "*active adaptive management*". Note in the following two CDEC charts that Delta salinity standards for post-June 15 were met despite efforts to relax them. The only real change that occurred was OMR OCAP protections no longer applied after June, allowing exports to increase.

The relaxed standard (objective) for Emmaton is 2780 (critical year) 14-day running average. The standard for Jersey Point is 2200. The Emmaton numerical standard was exceeded for 8 straight days in late July, although mean daily 14-day average of the standard was never above 1000 (Figure 4). (Note: these standards were exceeded in the spring, yet the CM is not capable of assessing such exceedances.

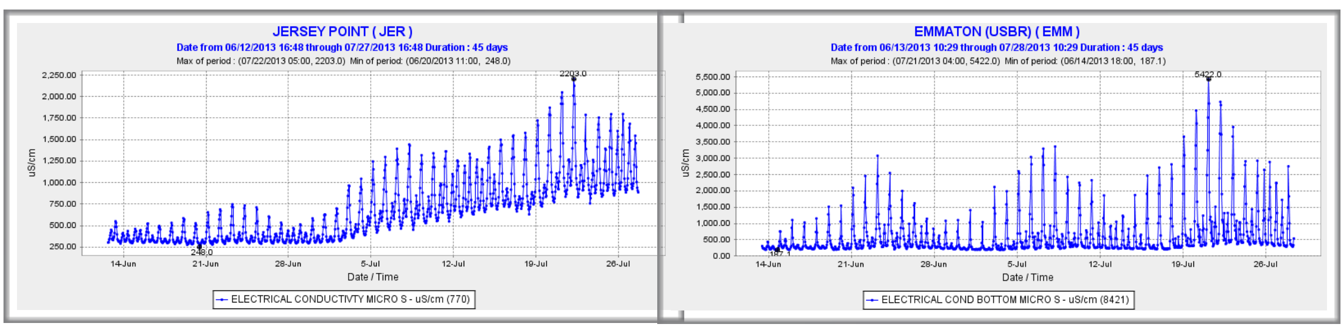


Figure 4a and b. EC at Jersey Point and Emmaton from mid June through July 2013.

OMR gradually deteriorated in June, especially late in the month in anticipation of the end of this OCAP BO restriction.

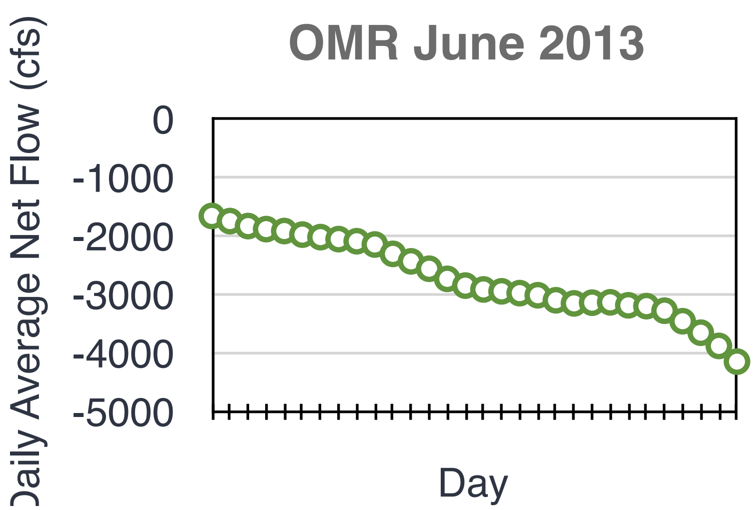


Figure 5. OMR in June 2013.

THE CONCEPTUAL MODEL

"The CM presented here in written and schematic form is intended to emphasize processes and their interactions over simple correlations, ensure that delta smelt vital rates remain central to thinking, and be useful to scientists as a routine organizational tool for testing hypotheses associated with the management actions. The CM includes processes and interactions during the entire year for all life stages of delta smelt, rather than focusing on specific time periods or regions, such as the fall low salinity zone (LSZ). 531

The key processes I was looking for in the model were the ongoing redistribution of young smelt from spawning areas to their summer rearing habitat in the low-salinity zone (LSZ), and the smelt reaction to changes in Delta hydrodynamics and location of the LSZ. I was also looking for what features of the LSZ are important to smelt (e.g., turbidity, food, salinity, temperature, etc.). I was also looking for what factors were influencing these important features (e.g., Delta inflow, outflow, hydrodynamics, exports, ag diversions and returns, Delta Cross Channel, Delta Barriers, tides, weather, etc.). I was especially looking for a keen awareness in the smelt physiology related to temperature, salinity, and even turbidity, as well as response to hydrodynamics (i.e., passive vs active movement). Most importantly, I was looking for whether the CM could indeed assess or predict changes such as those that occurred after mid June 2013.

As for "*vital rates"* I was looking for density distributions in time and space, as well as seasonal population abundance indices, and factors that appear to be related to them.

For me the key feature is vulnerability to the export pumps in the South Delta, as usually portrayed by location of the LSZ (1-6 ppt). As usual this important feature was shown by MAST as "X2" location or the average location of 2 ppt isohaline, in terms of kilometers from the Golden Gate (Figure 6).

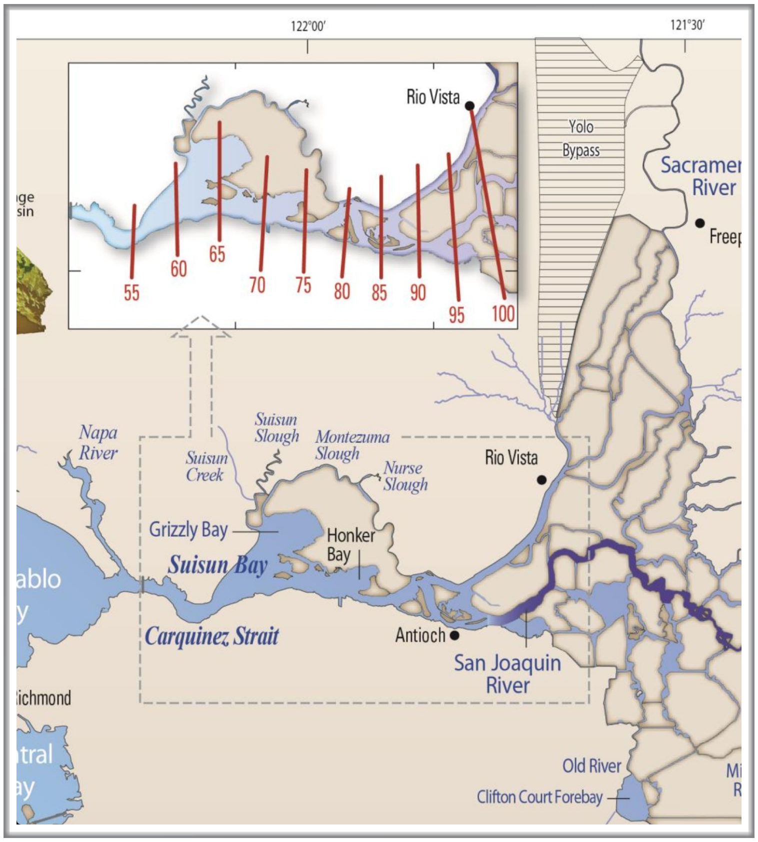


Figure 6. River kilometer designations for Bay-Delta. (Source: MAST Report)

DATA SOURCES AND ANALYSES 662

One key parameter and data element in the analyses that is not mentioned in this section is the smelt population size (it is brought up later in the report). Sometimes referred to as the stock of adults that produce the next yearclass or recruits (to the subsequent population). The relationship between these is termed the stock-recruitment curve or relationship. The important thing is that the number of young is related to the number of eggs produced by the females in the population. The corollary is that the number of females produced is related to the number of young (and eggs) produced.

Indices of abundance that are described in this section are estimates of stock and recruitment. Larval abundance indices and summer juveniles may be representative of recruits. Fall midwater trawl indices may represent the recruits from the past years adults or may also be considered the stock of adults for the coming production. My point is that discussion of factors affecting these indices need account for the population size or state at the time (season or year).

CHAPTER 4: ENVIRONMENTAL DRIVERS AND HABITAT ATTRIBUTES

"*habitat is the sum of all physical and biological attributes affecting a species*. " 712

In reality, habitat is not additive as one attribute may be multiplicative, for example a lethal water temperature would make the total habitat of zero value. Habitats may also be limited to a maximum by one attribute, for example food supply may limit growth and survival to some maximum.

The important thing is that habitat affects growth, survival, and reproduction through food, competition, predation, etc. Habitat conditions can help smelt, but can also kill them.

Water Temperature 718

As stated in the report water temperature affects nearly all aspects of habitat in direct or indirect ways. What is left wanting in this section is the extreme danger or risk under which the smelt population exists from high water temperatures in the Delta. Such risk is minimal in the Bay because of cooler water temperatures. Any management scheme that brings smelt into the Delta puts the population under severe risk. Some say this is "natural", but such risks and potential adverse population effects are more easily absorbed by healthy abundant populations with lots of built in diversity, not populations on the brink of extinction in a highly altered Delta. Furthermore, "natural" occurrence of smelt in the Delta does not occur under high inflows (or high exports).

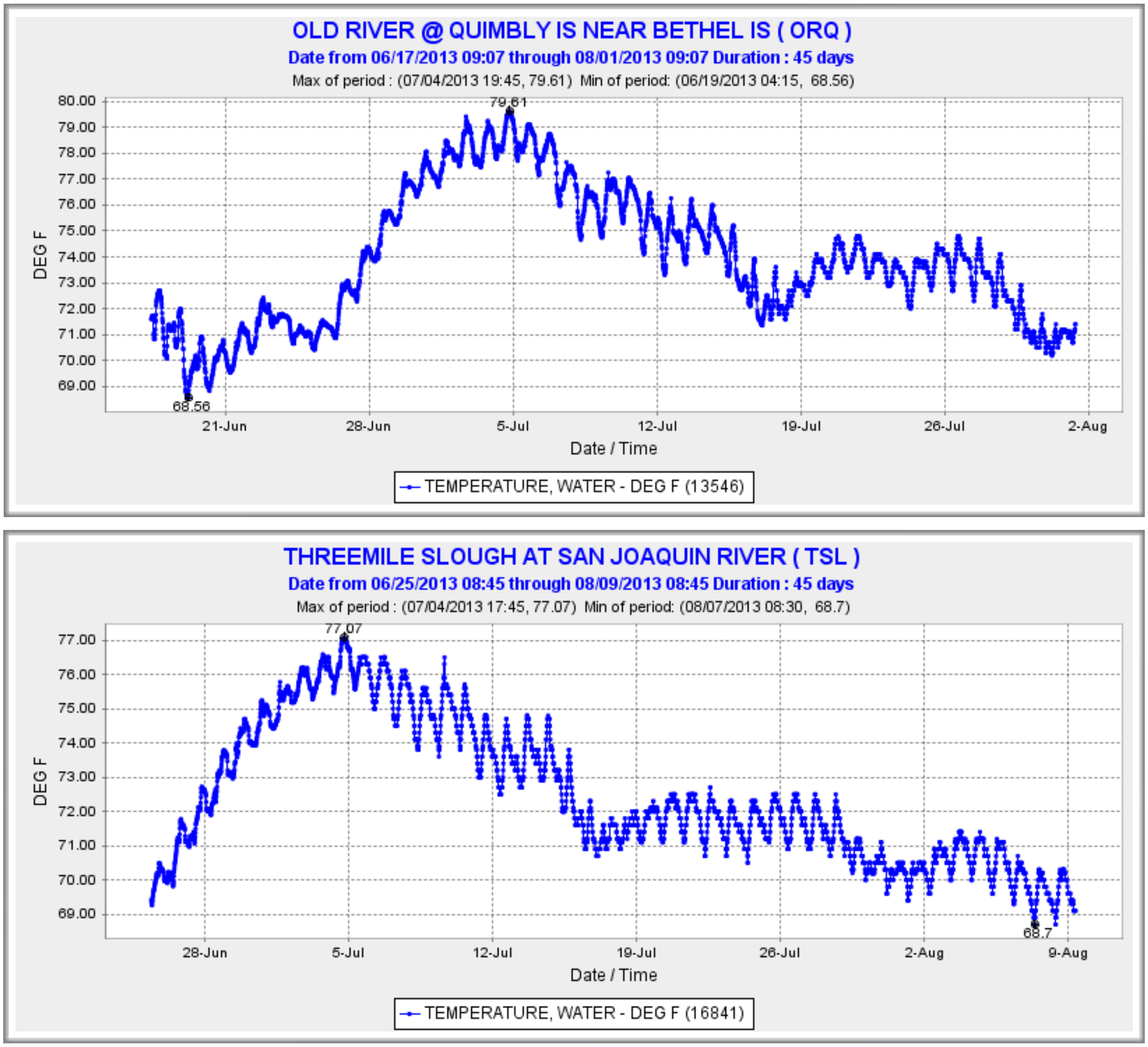


Figure 7a and b. Water temperatures at Threemile Slough and Old River in Central Delta from late June through early August 2013.

"At Antioch, the approximate center of the delta smelt distribution in the late summer and fall, seasonal variation in daily average temperature ranges from about 10°C to 24°C." 753. This is exactly what the problem was in early summer 2013 when the LSZ with its smelt reached and passed upstream of Antioch. Leaving the cooler air of the Bay for the hot air of the Delta during a heat wave under low Delta Outflow resulted in most of the LSZ reaching a minimum of 25C (77F). The forward edge moved into Old River in the Central Delta where water temperatures reached 27C (80F) (Figure 7).

Having the LSZ in the Delta at this time of year is extremely risky to the smelt population. In contrast, in the smelt "wonder-year" 2011, slightly higher outflow kept the LSZ in cooler Eastern Suisun Bay (and the smelt away from the Delta and export pumps).

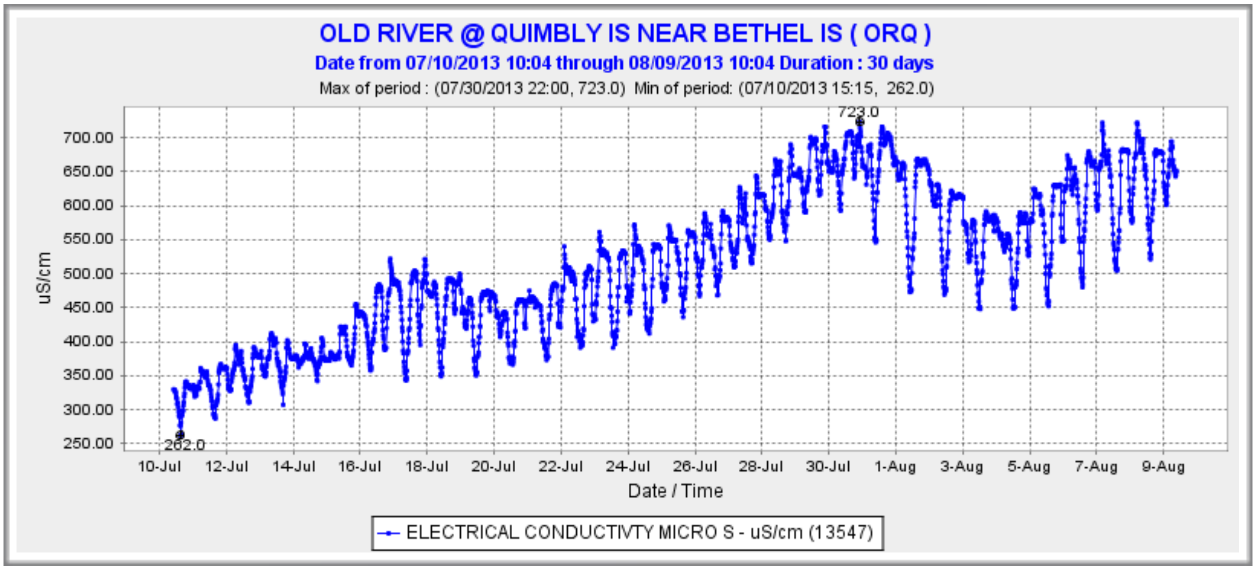
Instead of an OMR constraint, a superior OCAP SMELT BO condition should be location and water temperature in the LSZ through the summer. OMR through June is a poor protection criteria at best; it does not protect smelt, because it has nothing to do with outflow or temperature. Furthermore there is no OMR constraint that protects smelt when the LSZ enters the Central Delta in July when exports are 10,000 cfs and water temperatures are 80F throughout including the entire Clifton Court Forebay.

"As temperature increases beyond the optimum, metabolic rate continues to increase but physiological processes become less and less efficient and more energy is required just to meet the basal metabolic rate of the organism. Eventually, the metabolic rate begins to decline as temperatures go beyond the physiological limits of the organism and the basal metabolic rate can no longer be maintained. At higher temperatures the organism will die quickly. At the stressful temperatures beyond the optimum but below the lethal level, the ability to grow and mature might be impaired or over some period of time could be lethal. In addition, resistance to disease and contaminants could be affected." 778-784

With optimal water temperatures for smelt about 18-20C, these are profound words that should be the key feature of the MAST CM and a stated primary reason for the decline of smelt (and POD) in the Bay-Delta.

Size and Location of the Low Salinity Zone 856

"The position of the LSZ is commonly expressed in terms of X2, which is the distance from the Golden Gate in km along the axis of the estuary the salinity 2 isohaline measured near the bottom of the water column (Jassby et al. 1995). The intent of using X2 as an index was to develop an easily-measured, policy-relevant indicator with ecological significance for multiple species and processes (Jassby et al. 1995). In this context, the position of the LSZ as indexed by X2 is more easily measured than delta outflow because under most circumstances tidal flows are much larger than the net outflow, making net flows difficult to determine from field measurements". 861-867



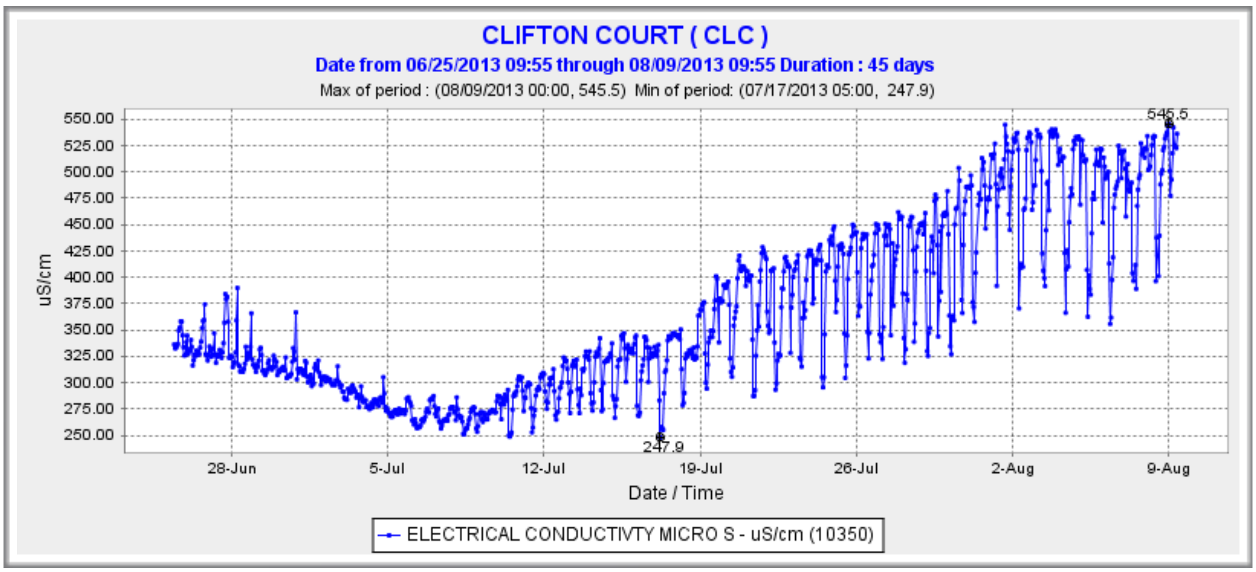


Figure 8a and b. EC at Clifton Court and Old River early summer 2013.

Having a daily-average X2 at Antioch does not represent the risk of having the LSZ upstream in Old River extending into Clifton Court Forebay at high tide, especially when the Forebay exports gulp 20,000 cfs at high tides with effects nearly back to Antioch. Furthermore, once pulled into the Delta the LSZ is ripped apart by huge cross freshwater Delta inflows from Three Mile Slough and the Mokelumne Forks. Pieces of the LSZ are carved off and sent on down Old River to the Forebay, as seen in the charts above (Figure 8) where after early July 2013 the signature of the leading portion of the LSZ (300-500 EC) can be seen in the

Forebay at the southern end of Old River in the South Delta. Without OMR protections under consistent Delta outflow more of the LSZ is pulled into Old River.

The size and location of the LSZ is a key factor determining the quantity and quality of low salinity rearing habitat available to delta smelt and other estuarine species. LSZ size and location are determined by the interaction of dynamic tidal and river flows with the stationary topography of the region (Reclamation 2011, 2012). 868-871

Over the last 150 years, human flow manipulations and landscape alterations have greatly changed the location, extent, and dynamic movements of the LSZ and its interactions with other parts of the estuary. The seasonal and interannual variations have become muted, especially in the summer and fall (fig. 18). 878-881

These gross under-statements fail to tell the important story about the summer LSZ in dry years under D-1485 and D-1641 - nightmare summers for delta smelt and the POD.

The recruitment success of longfin smelt and striped bass, but not delta smelt, has been shown to increase with a more westward position of the LSZ during spring (Jassby et al. 1995). It has been hypothesized that persistent eastward location of the LSZ in the fall has negative effects on delta smelt (Reclamation 2011) based on the finding that these changes reduce habitat area for delta smelt and perhaps their abundance (Feyrer et al. 2007, 2010). Changes in the size, location, and dynamics of the LSZ likely also interact in complex ways with other changes, such as changes in sediment and nutrient loadings and resulting turbidity and nutrient dynamics and their effects on delta smelt and the food web. 912-918

The population of delta smelt and recruitment of young each year is strongly related to spring and summer LSZ position and that location has much to do with the POD. Surely fall position can be important as well, but not so important if all the smelt are already dead from summer conditions as in 2013 and earlier POD years (2001-2002). The most notorious year for delta smelt was 1981 when the last large population of smelt was decimated by high exports under low outflows through the summer of a dry year. Many of these so-called studies use salvage as a parameter in the analyses to determine effects on smelt - how can smelt be present in salvage when Old River and Clifton Court Forebay water temperatures are 80F?

This entire paragraph needs critical scientific review and much further analyses as it is the crux of much of the controversy.

Turbidity

Turbidity is not a habitat attribute in the sense we use in this report because we do not show delta smelt outcomes directly resulting from responses to turbidity (figs. 8-12). Clearly, studies have shown that distribution of delta smelt is correlated with turbidity (e.g., Feyrer et al. 2007, Nobriga et al. 2008). In the CM we chose to incorporate turbidity as a modifier of several important linkages between environmental drivers and habitat attributes that are important to delta smelt, primarily food visibility for small larvae, predation risk for all life stages and spawning cues for adults. If turbidity was incorporated as a habitat attribute and, for example, predation risk was discussed separately from turbidity, there would be a great deal of overlapping text between the two sections because turbidity interacts with the presence of predators to determine predation risk. This approach is not ideal but should reduce redundant text and contribute to clarity of presentation. Nonetheless, we recognize that turbidity by itself might also be considered as a habitat attribute. For example, it is possible that delta smelt experience stress in low turbidity habitat, which would in turn affect survival (likely through predation) but also in other direct ways such as lower growth and reduced egg production. However, we do not have evidence at this point to support that hypothesis. 925-938. *Sufficient turbidity also appears to be important to reduce overall environmental stress and increase survival of larval delta smelt (Lindberg et al. 2013). Thus, it seems likely that turbidity is important to the feeding success and survival of larval delta smelt in the wild*. 1025-1027. *Multiple field studies have established the association between elevated turbidity and the occurrence of delta smelt. The abundance of delta smelt larvae in the 20 mm Survey was well explained by salinity and Secchi depth, a proxy for turbidity (Kimmerer et al. 2009). Nobriga et al. (2008) found that juvenile delta smelt are strongly associated with turbid water, a pattern that continues through fall (Feyrer et al. 2007*). 1037-1041

Turbidity is a critical habitat element of the LSZ that smelt depend on for the many reasons described above. One of the reasons smelt are found in the LSZ is its higher inherent turbidity. Having all that low turbidity reservoir Delta inflow blow into the Delta to sustain exports and mix with the LSZ is causing much of the stated problem. Not only are exports shearing off the LSZ, but the high inflows sustaining exports and keeping the large part of the LSZ at bay are ruining many important features of the LSZ, especially turbidity. Yes, there is no food in the low turbidity reservoir water. Yes, the low turbidity reservoir water is too warm. Yes, the smelt are more vulnerable to predation in the low-turbidity reservoir water. Yes, the hot, non-turbid, low nutrient, reservoir water forced into the Delta from the east to replace exported water is stressful to the delta smelt and everything else of importance to the Bay-Delta. All would be better if exports did not take all these good attributes south.

The North Delta, especially the large open expanse of Liberty Island (flooded since 1998) and the adjacent Cache Slough region are also relatively turbid. Recent evidence suggests that Liberty Island acts as a sediment sink in the winter and a sediment source for the surrounding Cache Slough complex in the summer (Morgan-King and Schoellhamer 2012). 975-978

It would helpful if some of this higher turbidity source water could be transported into the LSZ in dry springs and summers. However, this entire North Delta complex has its own export problem and actually pulls water from the Delta (to meet its own water demands) instead of contributing water. Running a portion of the high reservoir Delta inflow through the Yolo Bypass via the Yolo Bypass would help.

There is strong evidence for a long-term decline in sediment transport into the upper estuary (Wright and Schoellhamer 2004), leading to a long-term increase in water clarity in the upper Estuary (Jassby et al. 2002, Feyrer et al. 2007, Jassby 2008). Jassby et al. (2002) documented a 50% decrease in total suspended-solids concentration (TSS; equivalent to suspended sediment concentration (SSC) in this estuary) in the Delta from 1975-1995. 989-993

Might not a tripling in exports and large increases in reservoir water inflows into the Delta over the last four decades, especially in drier years and subsequent changes to the LSZ have something to do with this?

Entrainment and Transport

The SWP and CVP pumps are capable of pumping water at rates sufficient to cause the loss of ebb tide flows and to cause negative net flows (the advective component of flow after removal of the diffusive tidal flow component) through OMR toward the pumps, thus greatly altering regional hydrodynamics and water quality (Monsen et al. 2007). Under these conditions, fish and other aquatic species in the Delta may be transported toward the pumps, or may swim toward the pumps if they are behaviorally inclined to follow net flow." 1063-1068

Ominous, but understated. Export pumps are easily capable of pulling X2 upstream 20 km in a matter of days or weeks. Without high inflows, pumping can easily remove the entire freshwater pool of the western Delta and eastern Suisun Bay and bring the LSZ from Pittsburg to Antioch. Yes, fish may be transported toward pumps. Entire migrations of smelt, splittail, striped bass, and salmon can be diverted from westward to southward and eastward. The 20,000 cfs gulps into Clifton Court Forebay can take tens of thousands of fish each day to their eventual deaths.

"The SWP and CVP have large fish protection facilities to reduce entrainment - the state Skinner Fish Protective Facility (SFPF) and the federal Tracy Fish Collection Facility (TFCF). The SFPF and TFCF are located at the intakes to the State and Federal export pumps on Old River in the southwestern Delta. Both facilities have fish screens that are used to capture and collect fish before they reach the pumps. The "salvaged" fish are then trucked to and released back into the western Delta. A variable fraction of these fish survive the capture, handling, trucking and release process (Aasen, in press, Afentoulis et al., in press, Morinaka, in press a)."1069-1075

First, many fish are lost before the "screens". Second, the "screens" are grossly inefficient, especially to fish smaller than 1-2 inches in length (as most smelt are in early summer). Third, most smelt die in salvage or trucking. The science of fish loss at exports has been well documented over the past 40 years, so why all the new "in press" science.

Delta smelt salvage has been recorded since 1982 (Morinaka, in press b). Similar to the TNS and FMWT results for delta smelt, delta smelt salvage has declined dramatically since the beginning of this time series (fig. 21). 1078-1080.

Smelt salvage was recorded back into the 60s. The worst year on record was 1981, another POD year - conveniently left out. The long term trend and positive relationship between salvage and survey indices is significant and not inconsequential.

The ratio of delta smelt salvage divided by the previous year's FMWT index has been used as a simple indicator of possible entrainment losses. For adult (December-March) salvage, this ratio has been variable over time, but particularly high in the first year of this time series (1982, a wet year) and again during the beginning of a series of drought years in 1989 and in the fairly dry "POD" *years 2003-2005 (fig. 23). Current management provisions to protect delta smelt (UFWS 2008) are aimed at keeping this ratio at no more than the average of the 2006-8 levels.* 1083-1088

Keeping salvage of adult smelt down in winter is commendable. A similar effort to reduce smelt loss in dry springs and summers like 1981, 2001-2002, and 2013 is needed.

Delta smelt were salvaged nearly year-round in the beginning of this time series, but delta smelt salvage now only occurs in December-June. This trend coincides with the near disappearance of delta smelt from the central and southern Delta in the summer (Nobriga et al 2008). 1101-1103

Wow, wonder why they would disappear - could it be 80F water temperatures or simple a quick ride to export pumps, or a short stay in Clifton Court Forebay.

"Only through June"? Seems quit a few were salvaged in July pre-POD in 2000 (Figure 9).

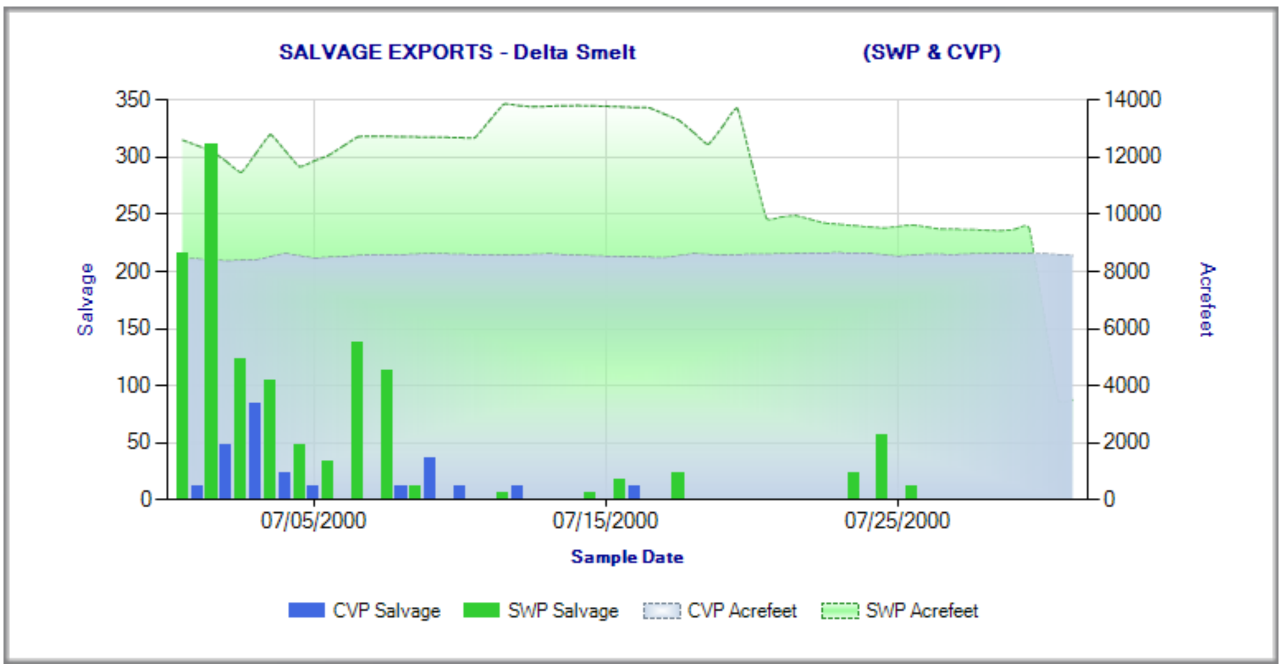


Figure 9. July 2000 delta smelt salvage.

Although methods to calculate proportional loss estimates have since been debated (Kimmerer 2011, Miller 2011), a number of modeling efforts show that high entrainment losses can adversely affect subsequent smelt generations (Kimmerer 2008, Thompson et al. 2010, Kimmerer 2011, Maunder and Deriso 2011). 1114-1117

Again, a gross understatement of the risks from direct entrainment loss. Just the losses in summer 1981 were sufficient to handicap the population for the 30 years since then. The lack of salvage is also not sufficient evidence to discount entrainment or indirect losses in dry years like 2013 being good examples. March and April entrainment loss should not be discounted especially in dry years like 2013 when OMRs were -4000 cfs.

For juvenile and adult delta smelt, Castillo et al. found that 94.3% to 99.9% of marked fish released into the SWP Clifton Court Forebay (CCF) were never salvaged and that salvage of marked fish decreased as the distance from the release sit to SFPF increased and as residence time in CCF increased. 1124-1127

Just apply these efficiencies to the chart above (Figure 9) - it is a simple proposition as to the role of entrainment. Using these on salvage estimates from 1981 clearly relates the risk of entrainment losses to the population. Or how about 2001 at the start of the POD (Figure10).

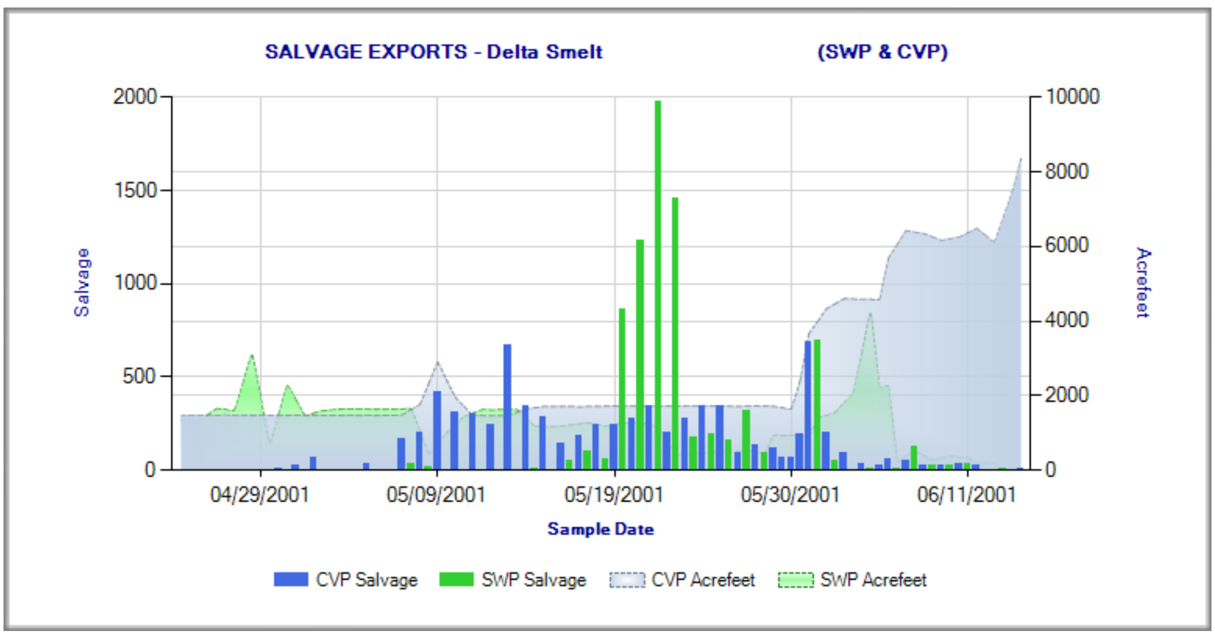


Figure 10. Spring 2001 delta smelt salvage.

Or how about May 25, 2002, in the second dry year of the POD (Figure 11).

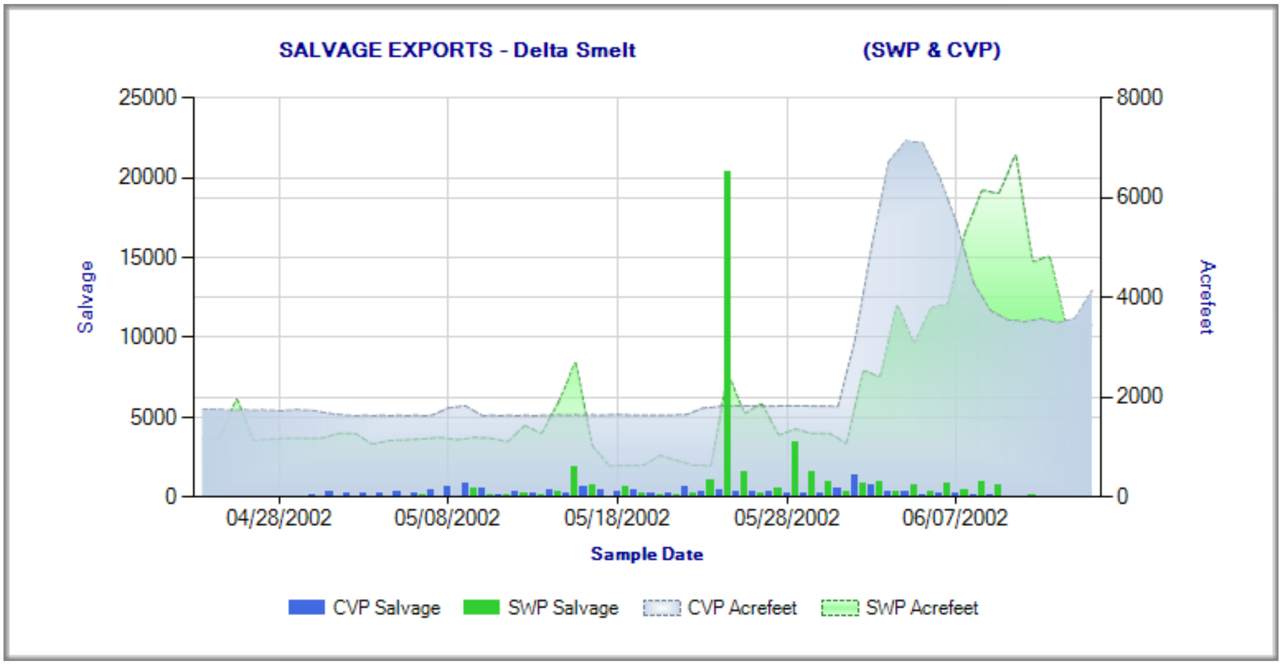


Figure 11 Spring 2002 delta smelt salvage.

High export rates can create negative flows past Jersey Point on the lower San Joaquin River ("Qwest," see Dayflow documentation: http://www.water.ca.gov/dayflow/output/Output.cfm) and negative OMR flows. 1176-1179

This whole subject of net transport in the western and central Delta and the vulnerability of smelt and the LSZ is skirted over for the most part. This is a critical point with considerable science and data on particle tracking and water column movement available. The whole subject of larval transport, distribution (smelt larval and 20-mm surveys), and entrainment (no larval entrainment data) is completely ignored. Most delta smelt entrainment loss likely occurs from March to June at the larval stage (Figure 12) - this is completely ignored - a shame given years of larval survey data. (Some discussion of larval losses occurs later in the report.) The smelt larval survey and the 20-mm survey are designed to provide risk of entrainment to larval and early juvenile smelt.

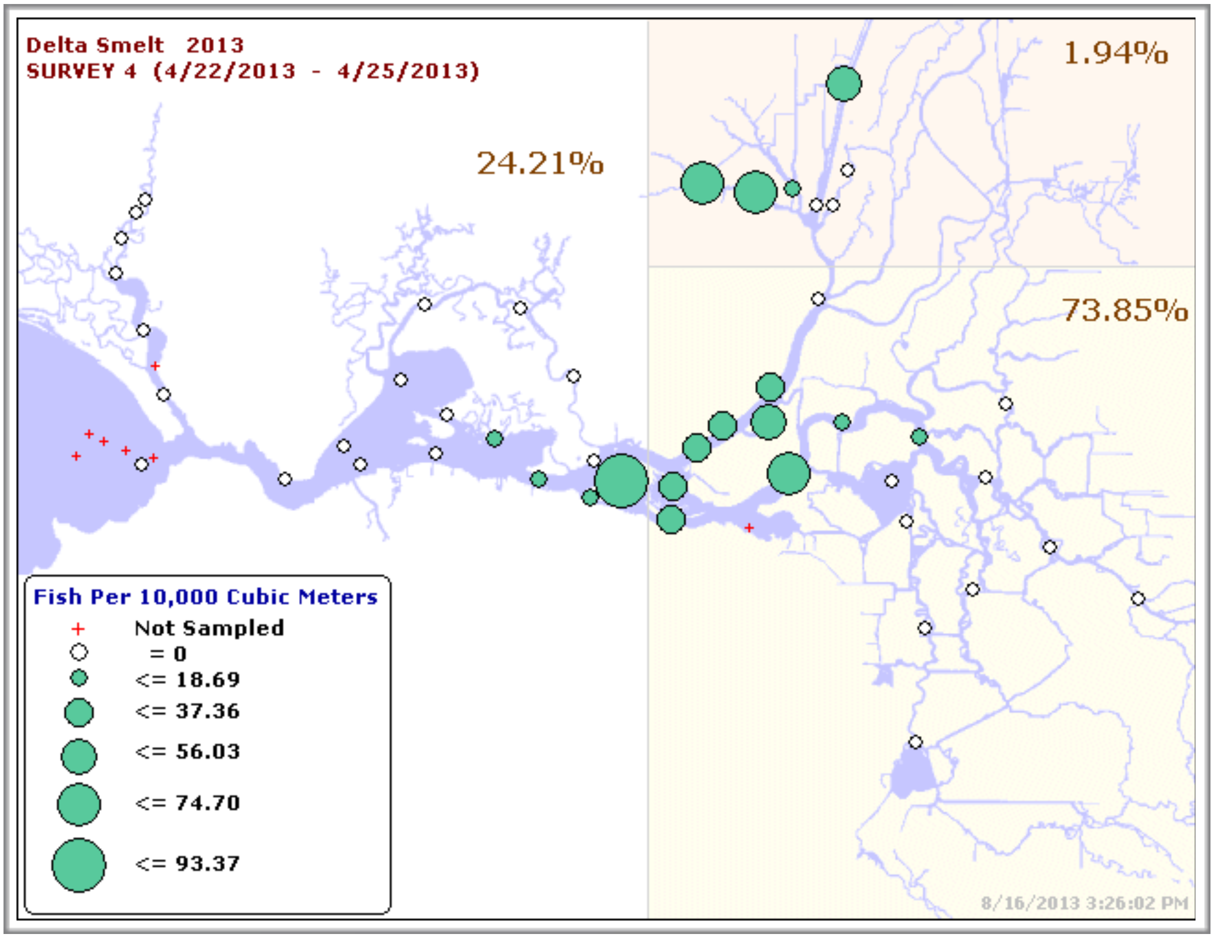


Figure 12. Spring 2013 delta smelt 20-mm survey.

Food and Feeding

As noted previously, the changes in phytoplankton production and phytoplankton species abundances observed and the invasion of P. amurensis may have had important consequences for consumer species preyed upon by delta smelt. For example, a major step-decline was observed in the abundance of the copepod E. affinis possibly due to predation by the overbite clam (Kimmerer et al. 1994) or indirect effects on copepod food supply. Predation by P. amurensis may also have been important for other zooplankton species (Kimmerer 2008). 1458-1463

Again, the consequence of exports and replacing high productivity Delta and LSZ water with unproductive reservoir water on smelt food supply is completely ignored. Over a half million acre-ft of water are exported each month in summer from the Delta at the export pumps. It takes one million acre-ft of reservoir water each month to replace the exported water. Might this not have some effect on Bay-Delta productivity? Should we really blame it all on the Asian clams?

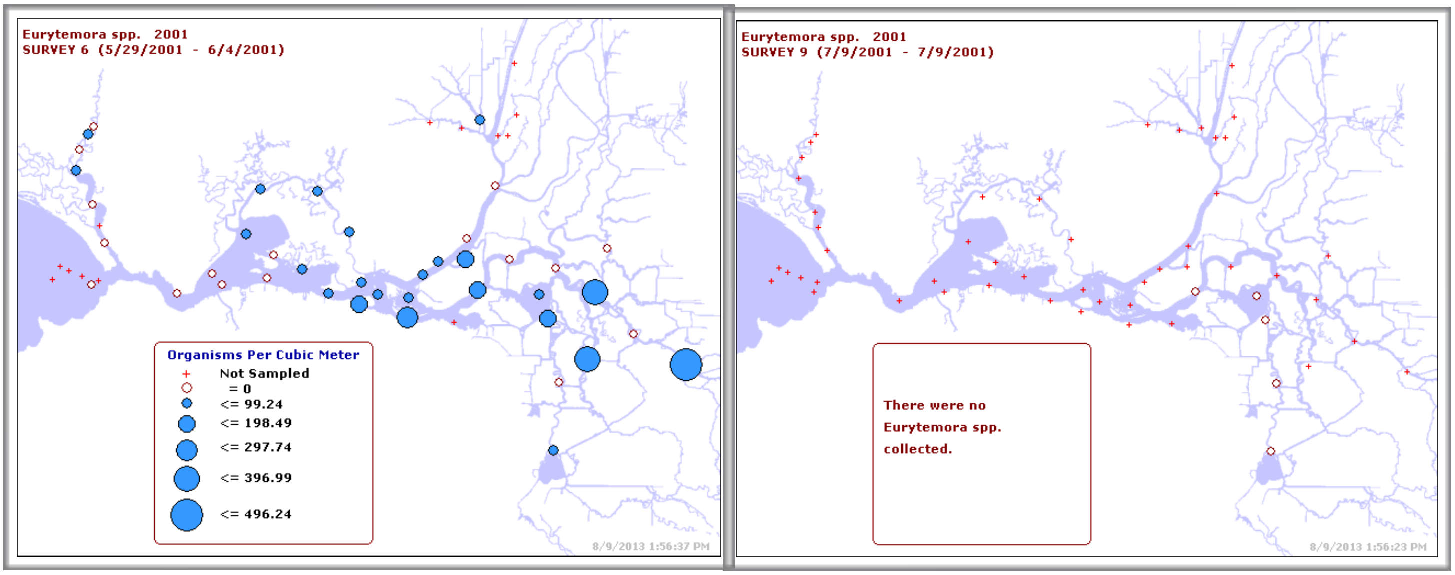


Figure 13. Late Spring and Summer Zooplankton Surveys 2001 data for Eurytemora, a smelt food..

Population Biology

In any form of a stock-recruitment model, there is a point at which low adult stock will result in low juvenile abundance and subsequent low recruitment to future adult stocks. This can occur even under favorable environmental conditions while the stock "rebuilds" itself. From a stock-recruitment perspective, the recent low abundance of delta smelt is of particular concern. Since about 2002, the current population is smaller than at any time previously in the record, with the exception of the 2011 year class (fig.3). 1627-1632

What we did for the little 2011 smelt population blip was pretty much reduced to nothing in 2012 and 2013. The ability of the population to produce enough eggs for recruitment is now severely compromised, much as it was in 1981, 1985, 1987, 1994, 2001-2002, 2005, and 2007-2009. The key now is to build the stock back up if however slowly.

Stage-to-stage survival has been explored using ratios of delta smelt abundance indices (fig. 40). The ratio of the TNS to 20 mm Survey gives a relative indicator of survival from larvae to *juveniles. The ratio of the FMWT to TNS gives a relative indicator of survival from juveniles to subadults.* 1647-1649

Ratios need not be used because they are statistically unstable in these stock/recruitment statistical regression analyses. The simple indices or logs are sufficient. The relationships are highly significant, with residuals and outliers readily explained by environmental factors.

Discussions in this section attempt to explain variability in stock and recruitment in informative ways, but lack the detailed analyses of conditions occurring in the specific years, seasons, months, and weeks, and rely to much on multiyear or seasonal indices, trends, and their ratios.

These observations strongly suggest that recent population trends for delta smelt are outside the historical realm of variability and may be associated with a new state of the system (Baxter et al. 2010). This inference is supported by a recent changepoint analysis, which indicated a decline in abundance in the early 2000s independent from environmental variables that previously explained abundance (Thomson et al. 2010). Thus, recovery is likely to require changes in the drivers that have produced the current low levels of abundance and perhaps new drivers or previous drivers that have since become more important. 1737-1743

The 2001-2002 dry years and 2012-2013 drier years clearly show the mechanisms for the POD. Years 2010-2011 shows the inherent ability to recover and how such recovery (higher young recruitment) can be accomplished. These dry year crashes and their associated PODs are clearly associated with operations under 1641 Delta outflow and export standards and ineffective OCAP BO restrictions. None of the discussions or analyses presented in this MAST report speak to these specific protections or their effectiveness. Nor do they hypothesize as to the potential benefits of specific changes to these protections. For example, it would seem reasonable to study or assess the effect of reducing outflows after June 15 of dry years. How hard would it be to raise outflow to 6,000, 7,000, or even 8,000 cfs, at least in warm periods, or cut back on exports from 10,000 to 8,000 or 7,000 cfs for periods of time. Or cut back on inflows when they are exceptionally warm. After all, managers seemed willing this year to accept even lower outflows with no specific considerations, because the "science" had indicated smelt are not at risk to exports in the summer. Maybe we shouldn't allow OMRs of -8,000 cfs in July in any year type. Daily records are meticulously kept on many parameters (e.g., water temp, EC, and turbidity) throughout the Delta (not just CDEC locations) by DWR to ensure water quality of export water.

In Summary

The MAST CM should be a useful tool for evaluating the proposed summer 2013 Delta Standards "relaxation", protections in D-1641 and OCAP BO, and suggested operation changes that might improve conditions for smelt and their critical habitat. At least the CM should show the folly of assuming smelt are not found in the Delta in summer and thus do not require export restrictions or outflow reduction constraints. The CM should also point out how little is known about spring larval entrainment or its effect, or what is going on with the smelt population at least in early summer. In this regards there needs to be a much closer look at the later 20-mm surveys, the earliest Summer-Tow-Net surveys, and the extensive hourly water temperature, turbidity, and EC data available throughout the Delta. Also, at what water temperatures do smelt die: at 23, 24, 25, 26, or 27C? Is the MAST CM ready to assess proposed changes under the BDCP? No!

Recommendations

The MAST CM needs a comprehensive population model, a risk assessment model, an analytical assessment analyses toolkit, and a habitat model that includes location-movement, EC, water temperature, entrainment, turbidity, predators, and food.

I challenge the MAST to develop a CM that can do or assess the following:

1. Assess the specific effects of no VAMP mid April to mid May export reductions on smelt in 2011-2013. (The ten-year VAMP experiment ended in 2010.)

2. Compare post-VAMP June and July in 2011, 2012, and 2013, wet, below normal, and dry years with different inflows, outflows, and exports on smelt and their habitat (EC and water temperature) and food supply.
3. Assess pre-VAMP and post-VAMP effects of delta smelt export entrainment on the smelt population. Can export entrainment of larval smelt be determined?
4. Assess the stock-recruitment relationships available for smelt using all available indices data. Relate residuals to habitat factors.
5. Assess the effect of no OMR caps after June. Are Outflows of 4000 ok, with exports at 11,000?
6. Assess the effects on Delta water temperatures from high summer Delta inflows, and their potential effect on smelt.
7. Assess where smelt reside in summer at different outflows. If all the LSZ is upstream of Antioch in July, are smelt not vulnerable to warm water and exports?
8. Assess the effect on smelt from spring closures of the DCC in dry years. Were smelt larvae not vulnerable to exports in Mar-Apr 2013 with the DCC closed and OMRs of -4000?
9. Determine empirically (from many years of survey data) at what temperature, salinities, and turbidities smelt are found and develop a habitat preference model for different life stages - seasons. Are smelt numbers ever lower because of predators-competitors? Can smelt survive in high salinity waters of the Bay downstream of the LSZ?

VAMP is Gone

Do We Miss It

Introduction

The Vernalis Adaptive Management Program or VAMP ended in 2010 after nearly a decade of service protecting Delta fish and their habitats. VAMP was a combination of enhanced San Joaquin Delta inflows and Delta export reductions (limitations) during the spring period from mid-April to mid-May[1]. The goal of VAMP was to improve survival of San Joaquin chinook salmon smolts migrating through the Delta to the ocean, but VAMP's limitation on exports (to 1500 cfs) wound up doing so much more. This report summarizes the benefits VAMP provided, what has replaced VAMP, and what protections are now lacking. A summary of the remaining fish protections follows, followed by a discussion of events in each of the past three post-VAMP years.

NMFS OCAP BO

How well does the NMFS OCAP BO[2] replace VAMP? First, it provides Old and Middle River (OMR) negative flow limitations to limit exports. Second, it provides San Joaquin inflow to export ratio criteria to limit exports. Third, it retains spring closures of the Delta Cross Channel.

SMELT OCAP BO

The Smelt Biological Opinion[3] replaced the VAMP protections with OMR limitations in the range of -1250 to -6100 cfs.

Delta Water Quality Standards - 1641

Under 1641, a flow pulse (3100-8600 cfs depending on water year type) is required from the San Joaquin River into the Delta from mid April to mid May.

---

[1] http://www.sjrg.org/peerreview/review_vamp_panel_report_final_051110.pdf

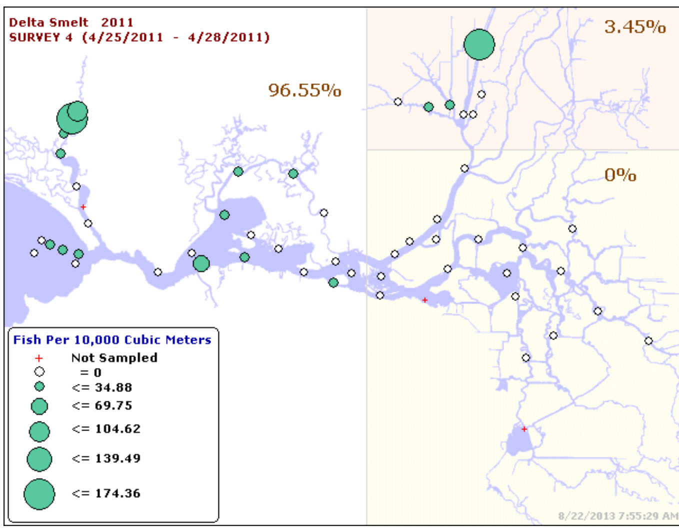
[2] http://www.swr.noaa.gov/ocap/doss/DOSS_annual_report_2011.pdf

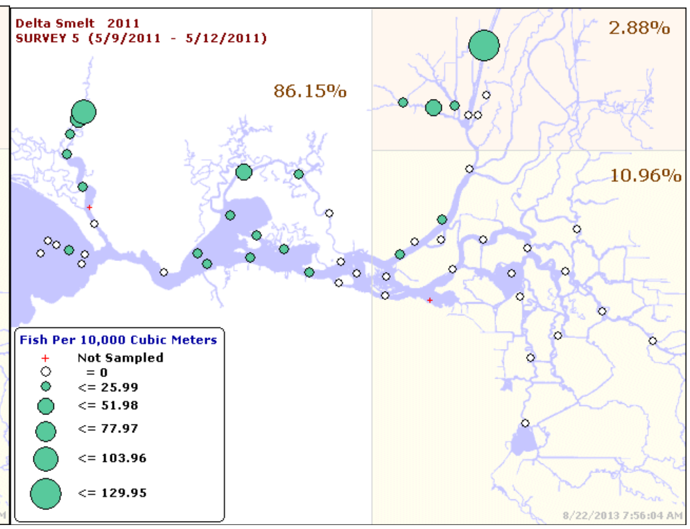
[3] http://www.fws.gov/sfbaydelta/cvp-swp/cvp-swp.cfm

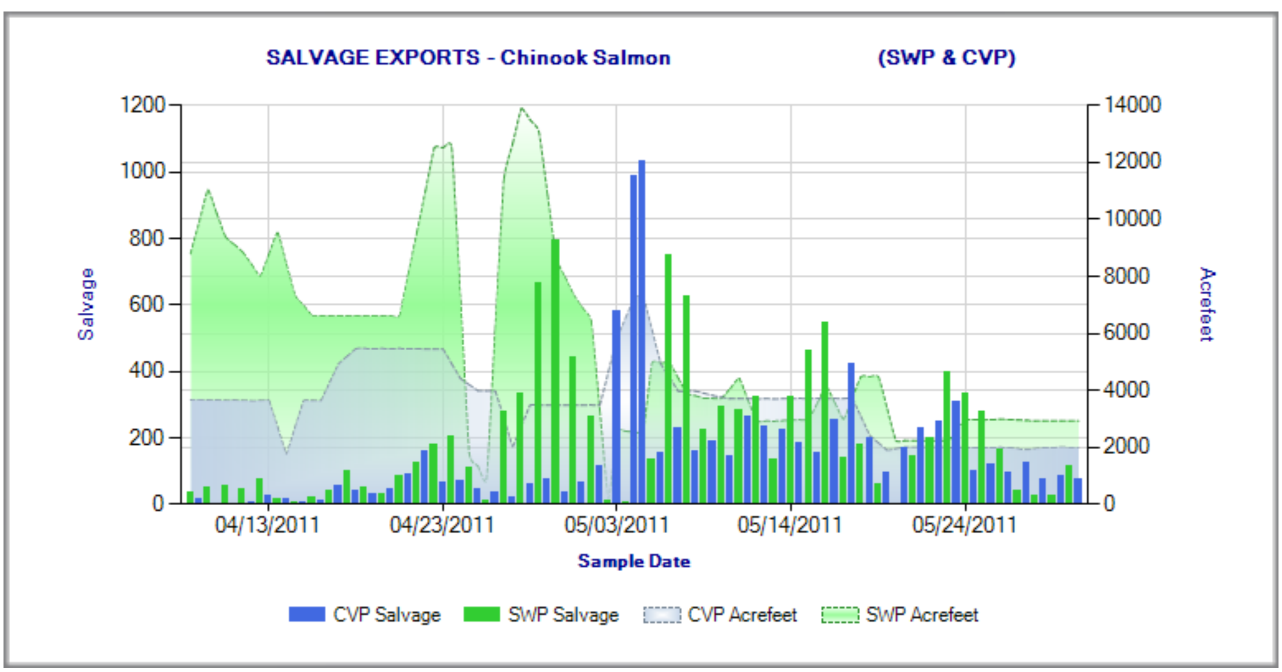
VAMP Period 2011

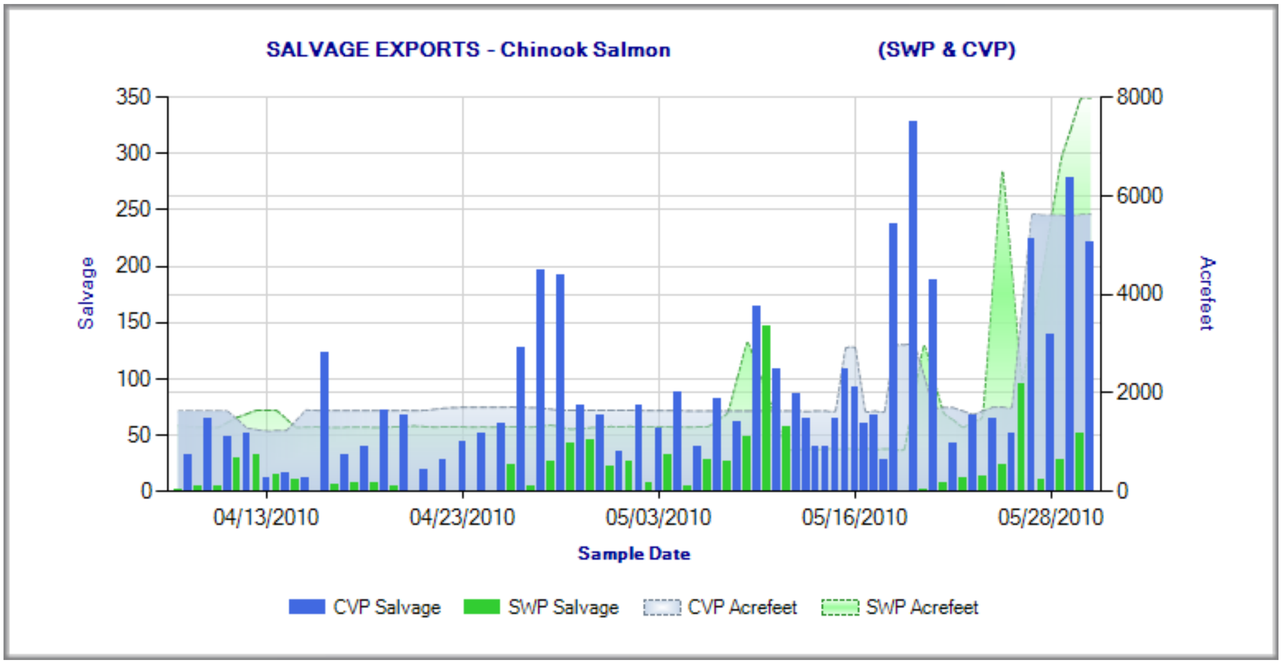
In 2011, the first year without VAMP, it was not missed, at least in terms of smelt protection. Year 2011 was a wet year with San Joaquin Delta inflows from mid April to mid May very high at 10,000-25,000 cfs, resulting in only a small percentage of the delta smelt population being in the Delta. Exports were 3,000-9,000 cfs, much higher than VAMP levels (1500 cfs in 2010). Smelt losses were very low, which was likely a major factor in the population recovery in 2011.

Salmon were salvaged in higher numbers because of the higher exports. Salvage was highest during peak exports. Salvage was roughly triple 2010 levels under VAMP 1500 cfs exports. With the Delta Cross Channel closed the burden of exposure to exports likely was on San Joaquin salmon.



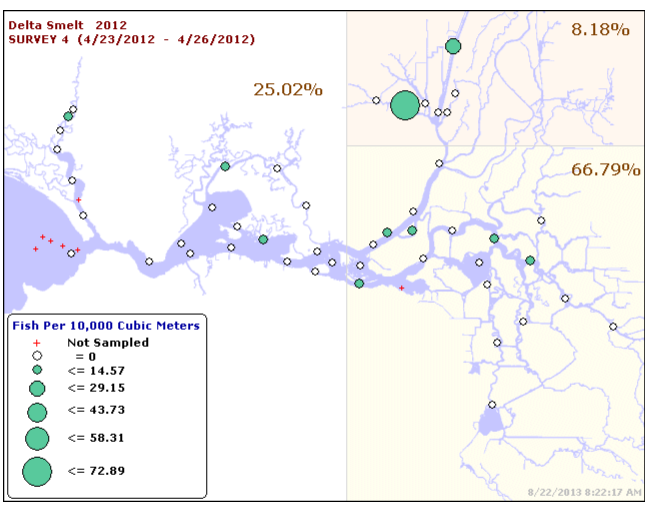


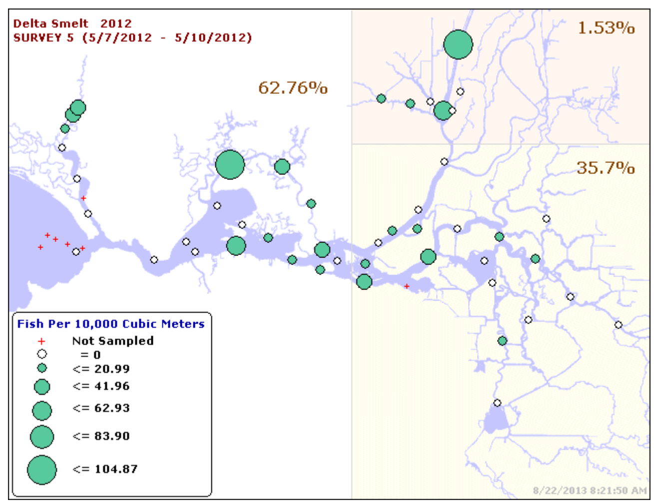




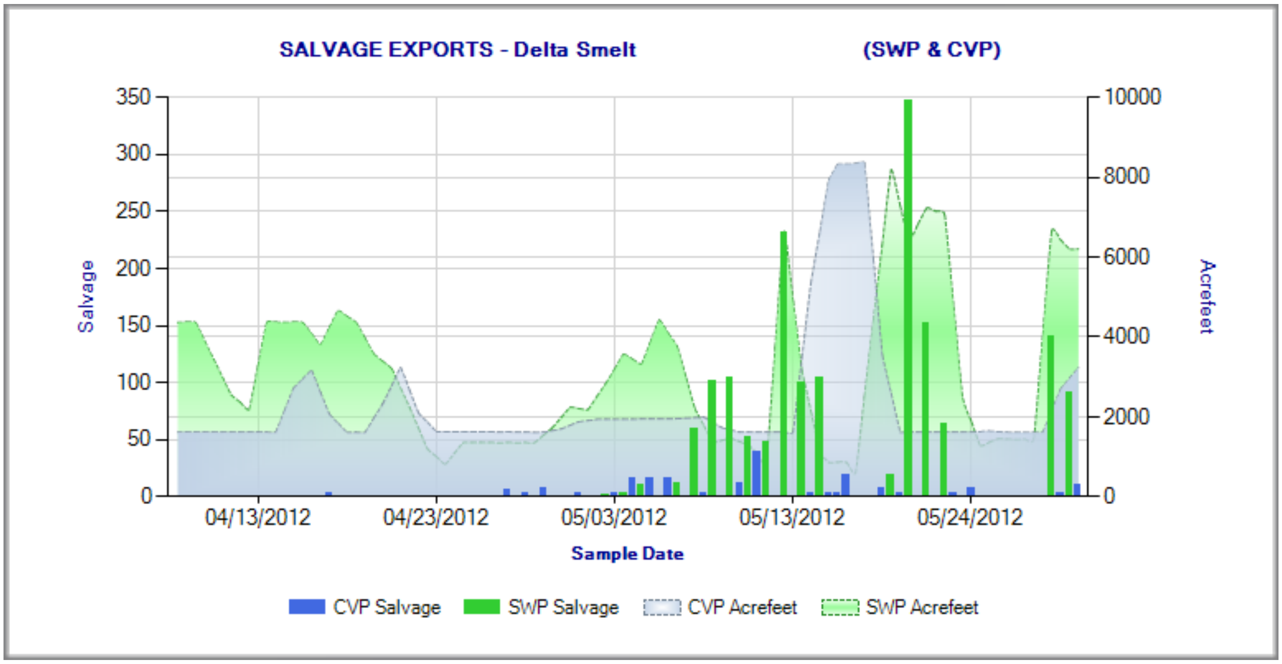
VAMP Period 2012

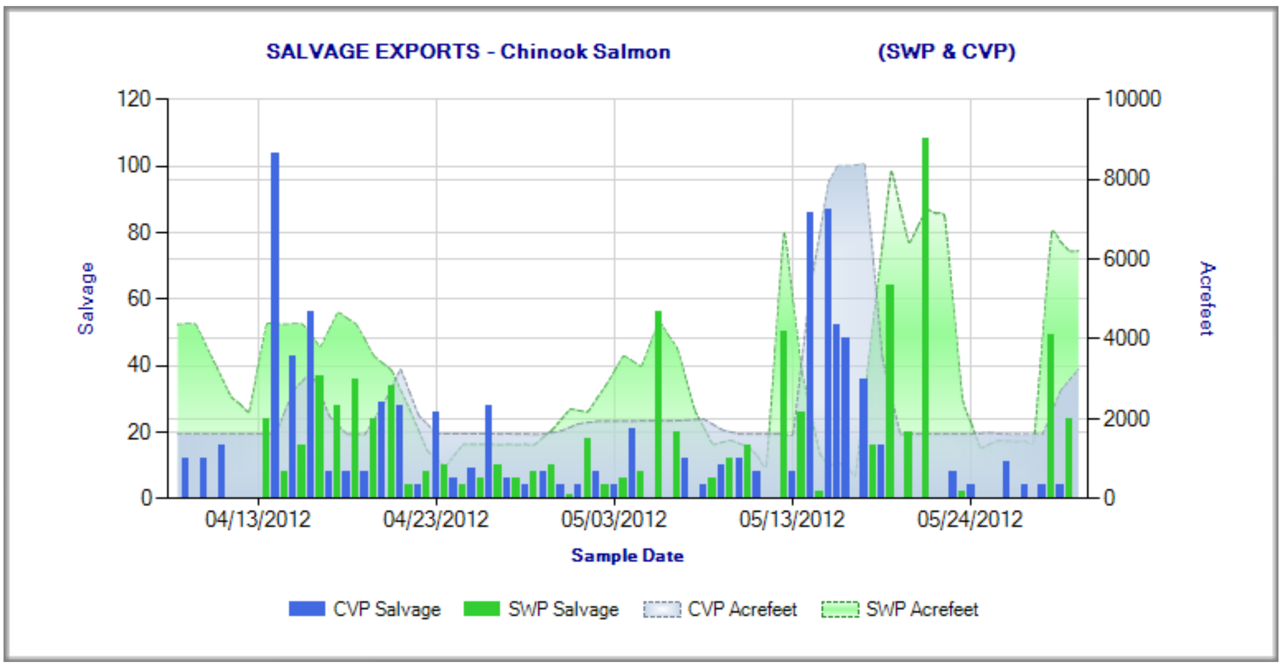
We really needed VAMP in the drier (Below Normal) 2012. A third to two-thirds of the smelt population was vulnerable to exports.

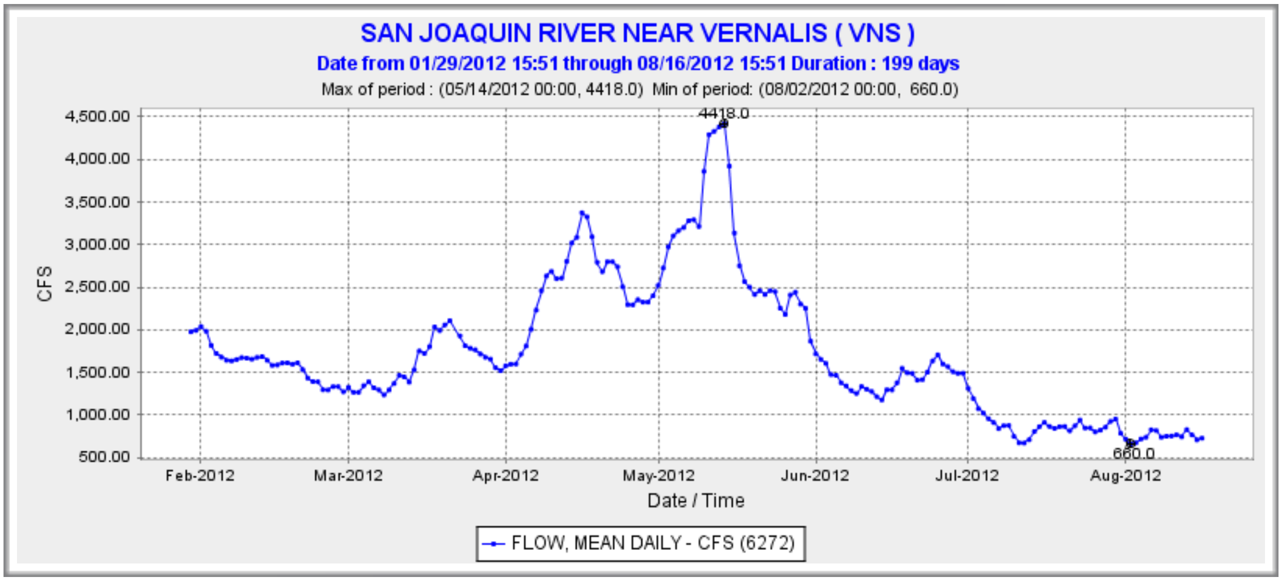




Some protections were provided by the BOs through limitations of exports and higher San Joaquin inflows, but exports reached 2000-4000 cfs (allowed with the pulsed flows) leading to a period of moderate smelt losses. Salmon salvage was relatively low under the low exports, but the closure of the DCC puts more of a burden on delta smelt and San Joaquin salmon.

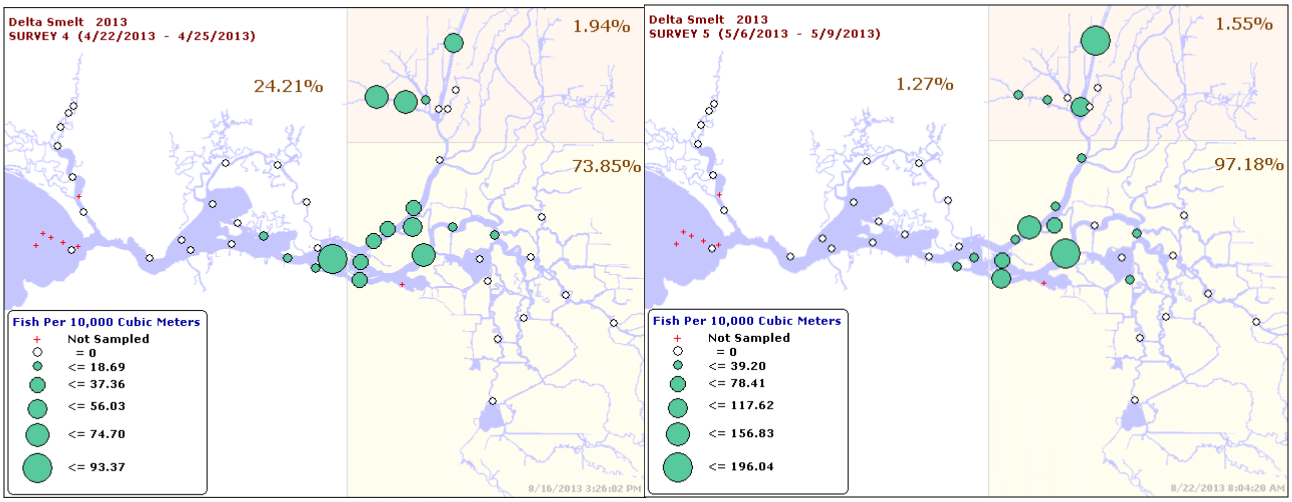

SALVAGE EXPORTS - Delta Smelt
(SWP & CVP)
Salvage
Acrefeet
350
300
250
200
150
100
50
0
10000
8000
6000
4000
2000
0
04/13/2012
04/23/2012
05/03/2012
05/13/2012
05/24/2012
Sample Date
CVP Salvage
SWP Salvage
CVP Acrefeet
SWP Acrefeet


SALVAGE EXPORTS - Chinook Salmon
(SWP & CVP)
Salvage
Acrefeet
120
100
80
60
40
20
0
10000
8000
6000
4000
2000
0
04/13/2012
04/23/2012
05/03/2012
05/13/2012
05/24/2012
Sample Date
CVP Salvage
SWP Salvage
CVP Acrefeet
SWP Acrefeet

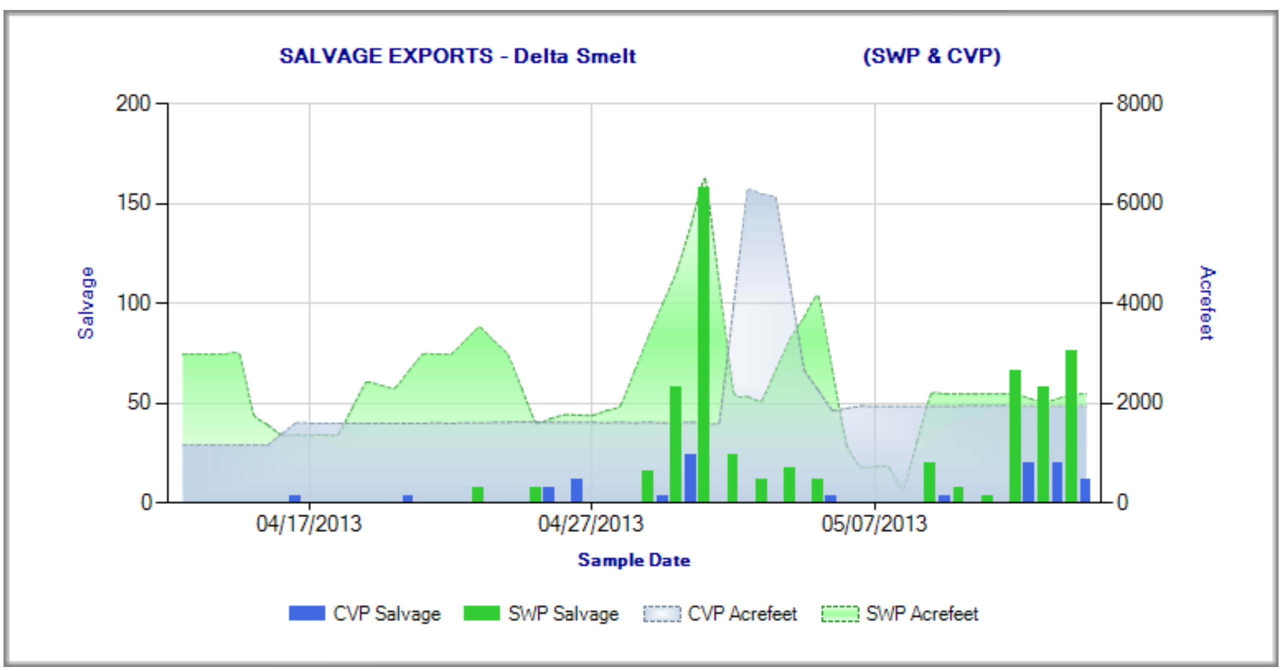

SAN JOAQUIN RIVER NEAR VERNALIS (VNS)
Date from 01/29/2012 15:51 through 08/16/2012 15:51 Duration : 199 days
Max of period : (05/14/2012 00:00, 4418.0) Min of period: (08/02/2012 00:00, 660.0)
4418.0
660.0
4,500.00
4,000.00
3,500.00
3,000.00
2,500.00
2,000.00
1,500.00
1,000.00
500.00
CFS
Feb-2012
Mar-2012
Apr-2012
May-2012
Jun-2012
Jul-2012
Aug-2012
Date / Time
FLOW, MEAN DAILY - CFS (6272)

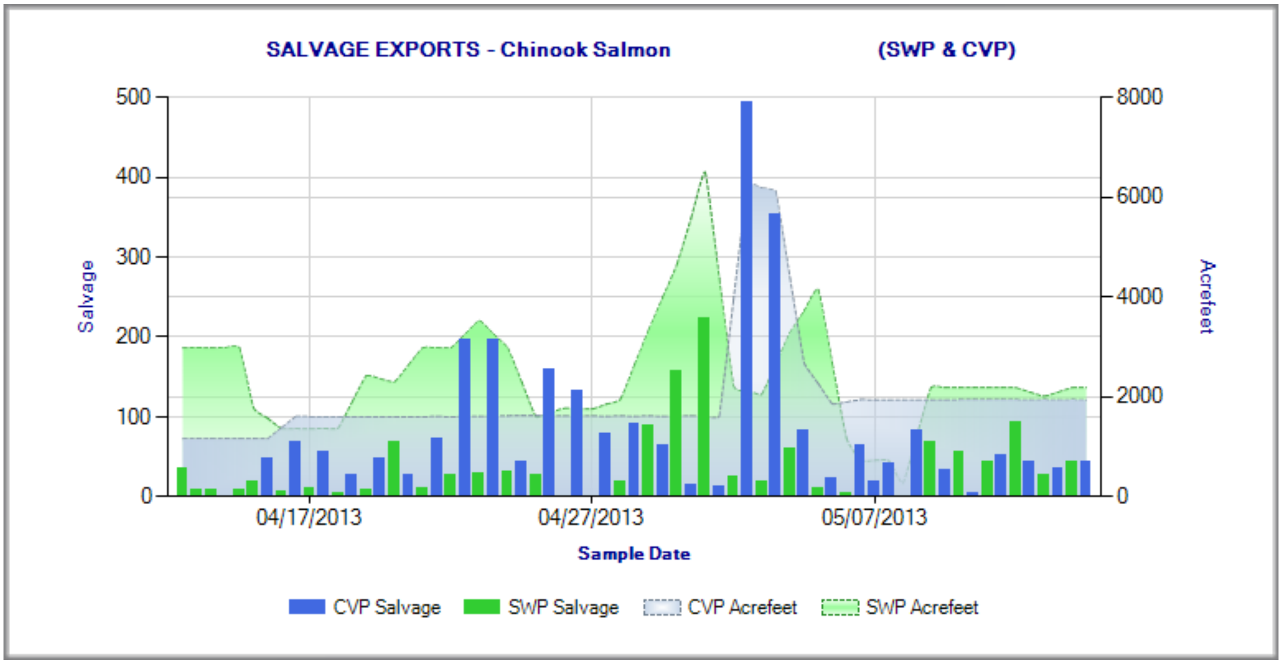
VAMP Period 2013

The loss of VAMP protections is hard on smelt and San Joaquin salmon in dry years like 2013. Much of the smelt population (74-98%) was in the Delta vulnerable to exports. Instead of 1500 cfs exports with VAMP, exports were 2000-4000 cfs (again allowed because of the flow pulse). With exports only controlled by OMR and I/E restrictions, exports ramped up during the late April-early May San Joaquin flow pulse, essentially negating any benefits of the pulse. In effect the pulse became a water transfer. Again,

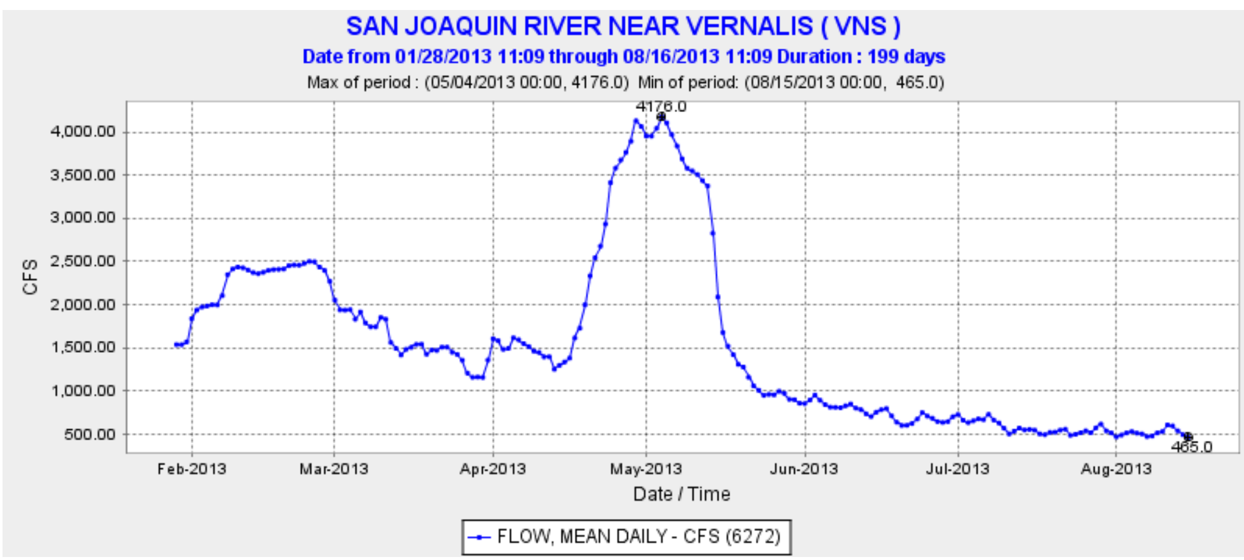


with the DCC closed the burden of the higher exports without VAMP is on smelt and San Joaquin salmon.





SALVAGE EXPORTS - Chinook Salmon
(SWP & CVP)
Salvage
Acrefeet
500
400
300
200
100
0
8000
6000
4000
2000
0
04/17/2013
04/27/2013
05/07/2013
Sample Date
CVP Salvage
SWP Salvage
CVP Acrefeet
SWP Acrefeet



SAN JOAQUIN RIVER NEAR VERNALIS (VNS)
Date from 01/28/2013 11:09 through 08/16/2013 11:09 Duration : 199 days
Max of period : (05/04/2013 00:00, 4176.0) Min of period: (08/15/2013 00:00, 465.0)
CFS
4,000.00
3,500.00
3,000.00
2,500.00
2,000.00
1,500.00
1,000.00
500.00
4176.0
465.0
Feb-2013
Mar-2013
Apr-2013
May-2013
Jun-2013
Jul-2013
Aug-2013
Date / Time
FLOW, MEAN DAILY - CFS (6272)

Summary and Conclusions

The OMR and I/E limitations in the OCAP BOs help to limit exports during the critical mid-April to mid-May period, but not enough during San Joaquin flow pulses. Higher exports during the flow pulses also negate the benefits of the flow pulse, essentially providing a water transfer back to the south. With the DCC closed to protect Sacramento salmon and steelhead there is a maximum impact of exports on delta smelt and San Joaquin salmon and steelhead. A simple solution to help reduce these effects is to not allow the export of San Joaquin flow pulses designed to help San Joaquin salmon and steelhead pass through the Delta and improve water quality.

SUMMER 2013

The demise of Delta smelt under D-1641 Delta Water Quality Standards

Thomas Cannon

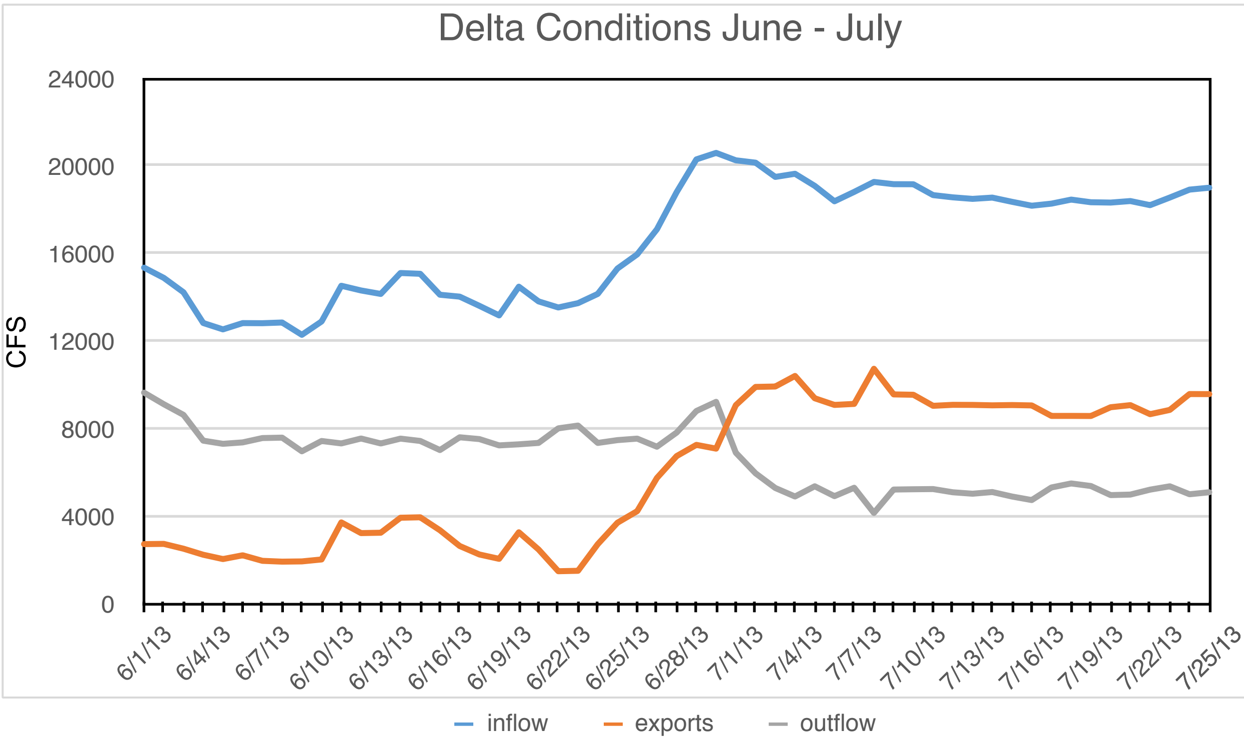
Consultant

Representing

California Sportfishing Protection Alliance

August 2013

Summer 2013



Dry Year Standards Relaxed?

Despite near record low precipitation in the Central Valley in the spring of 2013, the water year remained classified as "dry," pursuant to D-1641. The "dry year" standards for EC at Emmaton were violated in April, May and June and the EC standard at Jersey Point was violated in June. These standards were established to protect agricultural beneficial uses in the Delta.

The Department of Water Resources and the Bureau of Reclamation, fearing that water exports from the State and Federal Water Projects (Projects) would lead to violations of Delta outflow and western Delta EC standards and depletion of cold water storage in Shasta Reservoir, asked the State Water Resources Control Board on 24 May to reclassify the water year to "critically dry" and requested permission to move the temperature compliance point on the Sacramento River upstream from Red Bluff to Anderson to save the cold-water pool supply in Shasta Reservoir. The Department of Fish and Wildlife, NOAA Fisheries and US Fish and Wildlife Service submitted letters supporting the request.

While the State Board had no authority to arbitrary change a water year classification, it informed the agencies that it "will not object or take any action if the Bureau and Department operate to meet critically dry year salinity objectives for Western and interior Delta."

On or about June 22, the Projects began substantially increasing exports and Delta inflows, and shortly thereafter significantly reducing Delta outflow per the Delta Standards.

The D-1641 standards for a dry year (Figure 1) already allowed salinity to encroach into the West Delta at Emmaton and Jersey Point. Earlier violations of those standards in the spring had already exacerbated conditions by summer (it should also be noted that South Delta EC standards were also violated in June and July through August 15).

This report reviews conditions in the summer of 2013, the inadequacy of D-1641 dry year standards and the adverse impacts to Delta smelt caused by violation of those already inadequate standards.

TABLE 3 (continued)
WATER QUALITY OBJECTIVES FOR FISH AND WILDLIFE BENEFICIAL USES

COMPLIANCE LOCATION	INTERAGENCY STATION NUMBER(RKI 1[])	PARAMETER	DESCRIPTION (UNIT) [2]	WATER YEAR TYPE [3]	TIME PERIOD	VALUE
DELTA OUTFLOW						
		Net Delta Outflow Index (NDOI) [7]	*Minimum monthly average [8] NDOI (cfs)*	*All*	*Jan*	*4,500 [9]*
				All	*Feb-Jun*	*[10]*
				W,AN	*Jul*	*8,000*
				BN		*6,500*
				D		*5,000*
				C		*4,000*
				W,AN,BN	*Aug*	*4,000*
				D		*3,500*
				C		*3,000*
				All	*Sep*	*3,000*
				W,AN,BN,D	*Oct*	*4,000*
				C		*3,000*
				W,AN,BN,D	*Nov-Dec*	*4,500*
				C		*3,500*
RIVER FLOWS						
Sacramento River at Rio Vista	*D-24 (RSAC101)*	*Flow rate*	*Minimum monthly average [11] flow rate (cfs)*	*All*	*Sep*	*3,000*
				W,AN,BN,D	*Oct*	*4,000*
				C		*3,000*
				W,AN,BN,D	*Nove-Dec*	*4,500*
				C		*3,500*
San Joaquin River at Airport Way Bridge, Vernalis	*C-10 (RSAN112)*	*Flow rate*	*Minimum monthly average [12] flow rate (cfs) [13]*	*W,AN*	*Feb-Apr 14 and May 16-Jun*	*2,130 or 3,420*
				BN,D		*1,420 or 2,280*
				C		*710 or 1,140*
				W	*Apr 15-May 15 [14]*	*7,330 or 8,620*
				AN		*5,730 or 7,020*
				BN		*4,620 or 5,480*
				D		*4,020 or 4,880*
				C		*3,110 or 3,540*
				All	*Oct*	*1,000 [15]*

Figure 1a. D-1641 EC Water Quality Objectives Table 2.

TABLE 2
WATER QUALITY OBJECTIVES FOR AGRICULTURAL BENEFICIAL USES

COMPLIANCE LOCATION	INTERAGENCY STATION NUMBER (RKI [1])	PARAMETER	DESCRIPTION (UNIT) [2]	WATER YEAR TYPE [3]	TIME PERIOD	VALUE
WESTERN DELTA						
Sacramento River at Emmaton	*D-22 (RSAC092)*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily EC (mmhos/cm)*		*0.45 EC April 1 to date shown*	*EC from date shown to Aug 15 [4]*
				W	*Aug 15*	*----*
				AN	*Jul 1*	*0.63*
				BN	*Jun 20*	*1.14*
				D	*Jun 15*	*1.67*
				C	*----*	*2.78*
San Joaquin River at Jersey Point	*D-15\ (RSAN018)*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily EC (mmhos/cm)*		*0.45 EC April 1 to date shown*	*EC from date shown to Aug 15 [4]*
				W	*Aug 15*	*----*
				AN	*Aug 15*	*----*
				BN	*Jun 20*	*0.74*
				D	*Jun 15*	*1.35*
				C	*----*	*2.20*
INTERIOR DELTA						
South Fork Mokelumne River at Terminous	*C-13 (RSMKL08)*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily EC (mmhos/cm)*		*0.45 EC April 1 to date shown*	*EC from date shown to Aug 15 [4]*
				W	*Aug 15*	*----*
				AN	*Aug 15*	*----*
				BN	*Aug 15*	*----*
				D	*Aug 15*	*----*
				C	*----*	*0.54*
San Joaquin River at San Andreas Landing	*C-4 (RSAN032)*	*Electrical Conductivity (EC)*	*Maximum 14-day running average of mean daily EC (mmhos/cm)*		*0.45 EC April 1 to date shown*	*EC from date shown to Aug 15 [4]*
				W	*Aug 15*	*----*
				AN	*Aug 15*	*----*
				BN	*Aug 15*	*----*
				D	*Jun 25*	*0.58*
				C	*----*	*0.87*

Figure 1b. D-1641 Flow Water Quality Objectives Table 3.

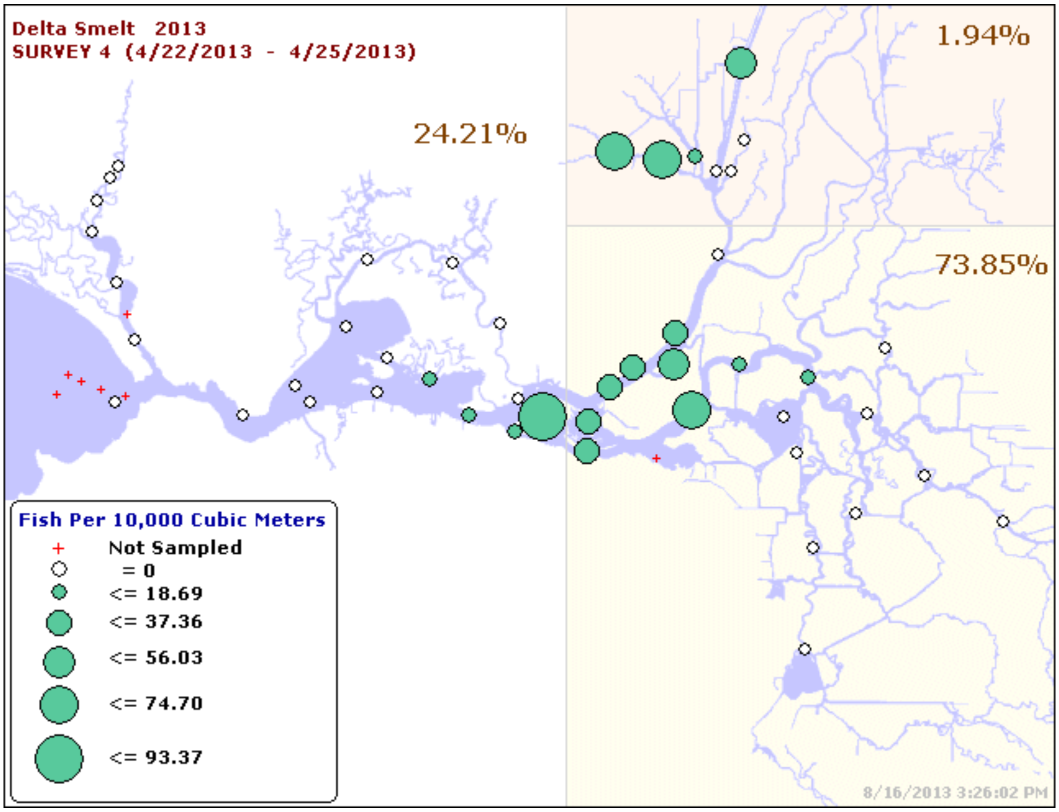


Figure 2. Late-April 2013, 20-mm Smelt Survey results. (Source: http://www.dfg.ca.gov/delta/data/20mm/)

Delta Smelt in April

Although not the subject of this report, spring conditions set the stage for summer. April 2013 was a tough time for smelt. Sacramento River inflow to the Delta dropped to only 6,000 cfs, San Joaquin inflows were 1500-3000 cfs, exports were up to 2,500-3,000 cfs, and outflow was as low as 6,000 cfs. Old and Middle River OMR flows were -1000 to -4000 cfs. The Delta Cross Channel was closed.

Over the past 20 years, the late April – early May period had been under the protection of CVPIA and VAMP (Vernalis Adaptive Management Program) protections, but these protections ended in 2010. This year, without these protections, late April exports climbed to 2,500-3,000 cfs reaching 4,000 cfs in early May (from 1500 cfs cap under VAMP). This increase in exports without the VAMP export cap occurred under lower inflows, outflows, and negative OMR flows. Nearly three quarters of the Delta smelt population was in the Central and Western Delta (20-mm survey, Fig. 2) and thus subject to being exported (especially with negative OMRs with the DCC closed). Most of the smelt were not of salvageable size (they were only 10-25 mm), so they were entrained in the export water likely in large numbers (hundreds of thousands per day were moving into Old River toward pumps).

Despite these horrible conditions many still survived in the western Delta under the modest outflows and thus became subject to summer conditions.

Delta Smelt in Mid June

In mid June 2013 the small remnant population of delta smelt surviving in the San Francisco Bay-Delta after the below-normal water year of 2012 and poor spring conditions described above were spread through their usual dry-year habitats in the western Delta, eastern Suisun Bay, Montezuma Slough, and the Cache Slough/Bypass/Ship Channel complex in the north Delta (Figure 3).

Other than the north Delta group, most of the smelt were in their summer low-salinity zone (LSZ) home where salinities are low (0.5-5 ppt) and water temperature optimal (about 20C). With the protective dry-year EC standard of 0.45 through June 15, the LSZ was in eastern Suisun Bay west of the Delta.

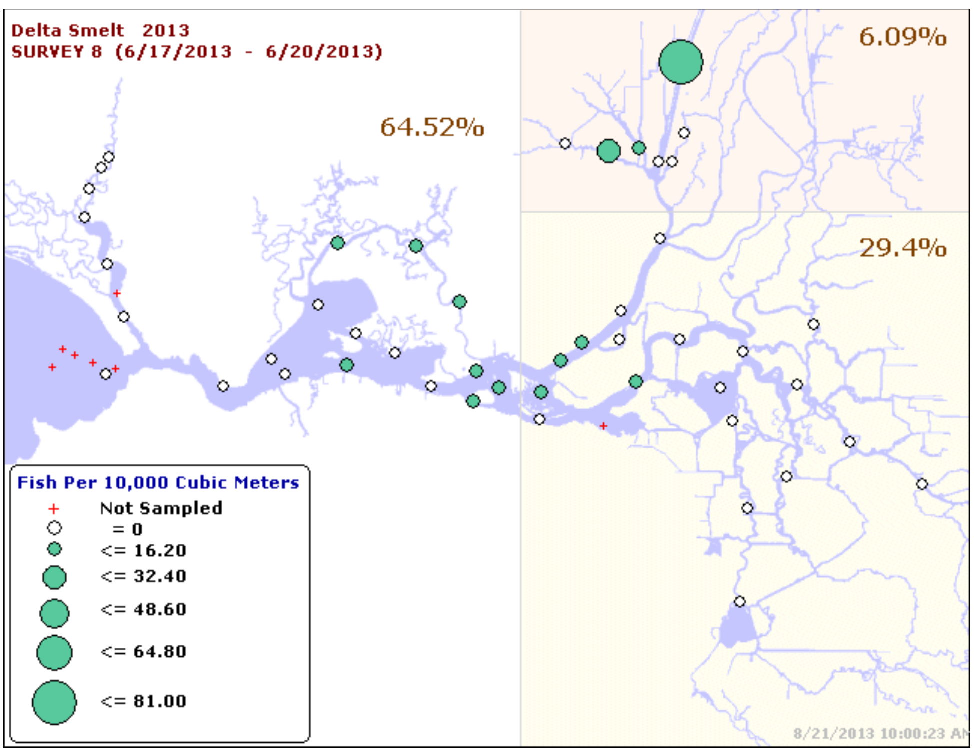


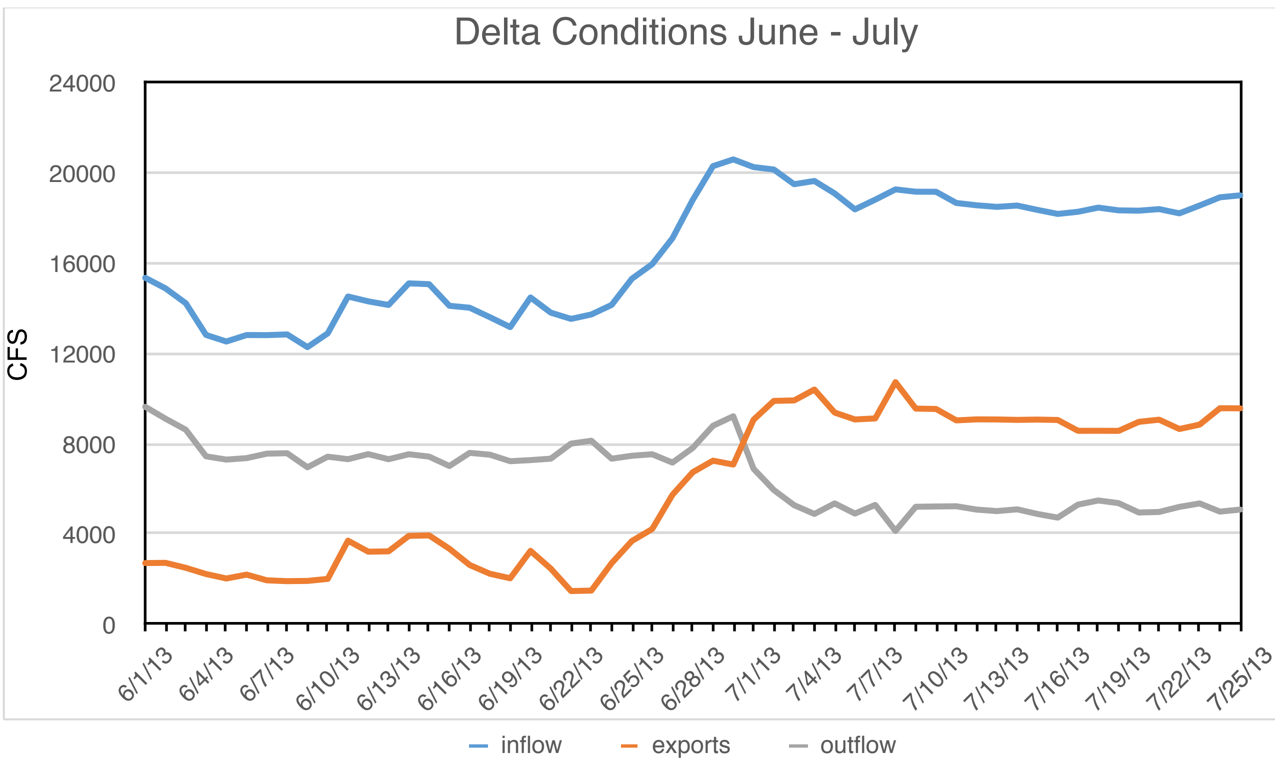
Figure 3. Mid-June 2013, 20-mm Smelt Survey results. (Source: http://www.dfg.ca.gov/delta/data/20mm/)

Summer Flow and Salinity Conditions

Beginning in the third week in June, inflow increase from the 12,000-14,000 cfs level to 20,000 cfs and exports increased from 2,000 to 10,000 cfs (Figure 4). A week later Delta outflow was reduced to 5,000 cfs.

West Delta

The effect is seen in the EC patterns at Emmaton and Jersey Point in the west Delta (Figures 5a and 5b). As outflow declines, salinities (EC) increase. The LSZ with its 500-6000 EC signature moved upstream into the West Delta with each incoming tide. In contrast, in wet year 2011, outflow was maintained at 8000 cfs and the LSZ did not move upstream into the Delta (Figure



5c).

Figure 4. June through July 2013 Delta inflow, outflow, and exports. Summer EC standards kick in after mid June.

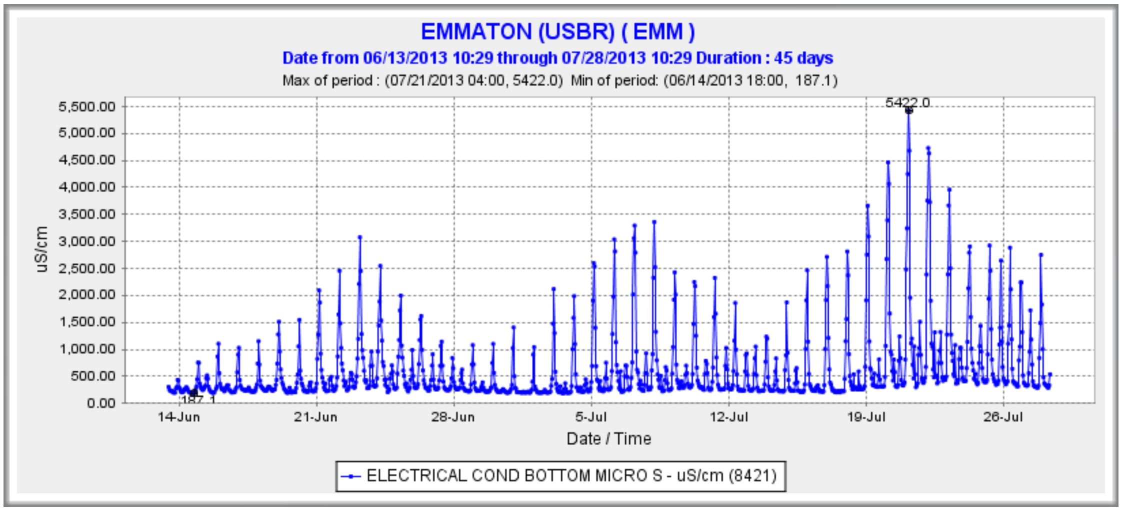


Figure 5a. Conductivity (EC) at Emmaton on lower Sacramento River in West Delta after mid June 2013. (Source: CDEC)

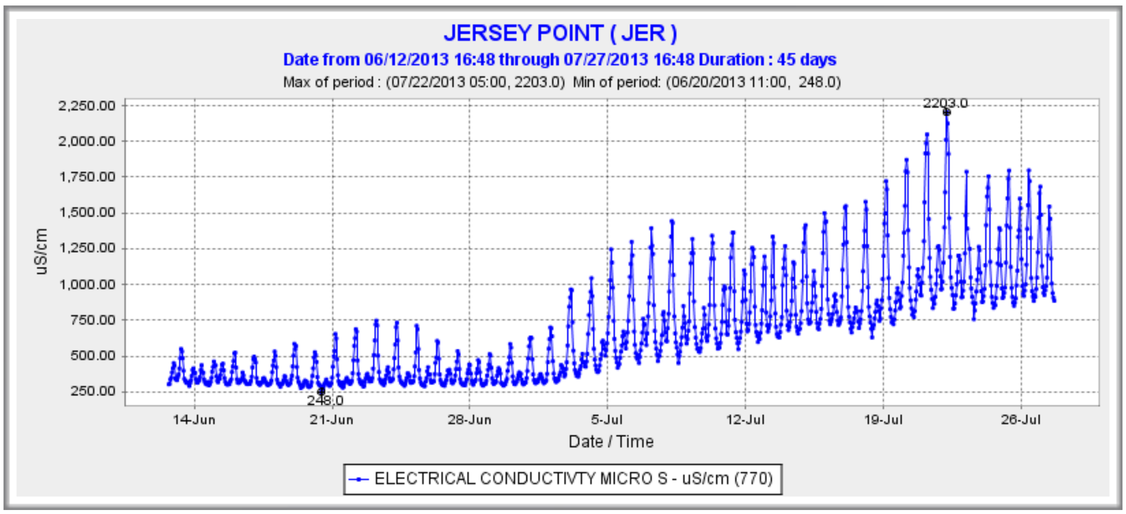


Figure 5b. Conductivity (EC) at Jersey Point on lower San Joaquin River in West Delta after mid June 2013. (Source: CDEC)

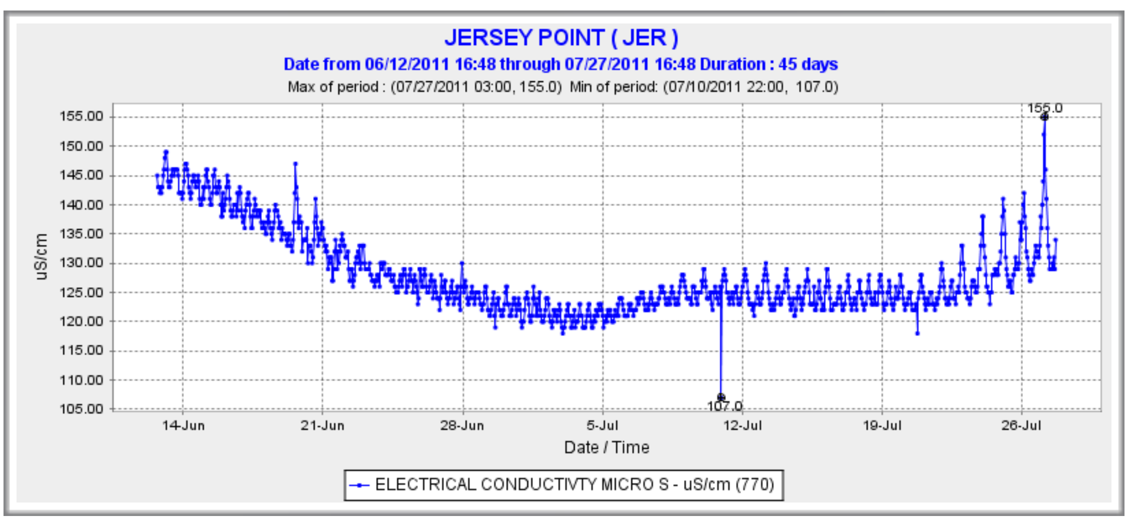


Figure 5c. Conductivity (EC) at Jersey Point on lower San Joaquin River in West Delta after mid June 2011. (Source: CDEC)

Salinity (EC) in Eastern Suisun Bay at Collinsville on the north and Pittsburg on the south also increased at the beginning of July with the decrease in outflow (Figures 6 and 7). At high tide the LSZ was well upstream of the two locations by early July. The lower end of the LSZ did extend downstream to these locations during low tides through July.

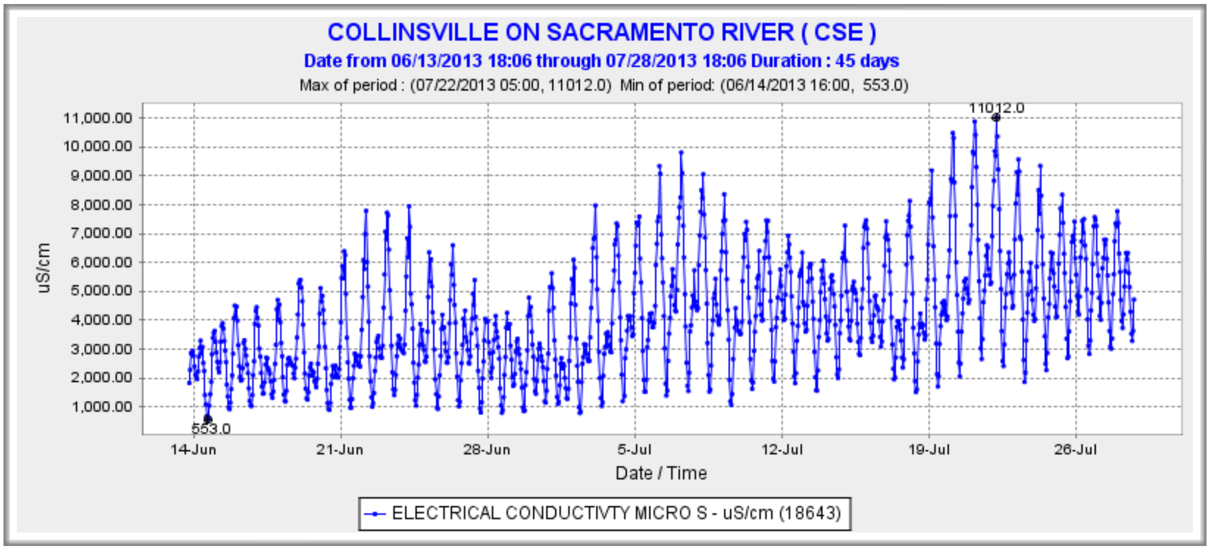


Figure 6. Conductivity (EC) at Collinsville in Eastern Suisun Bay after mid June 2013. (Source: CDEC)

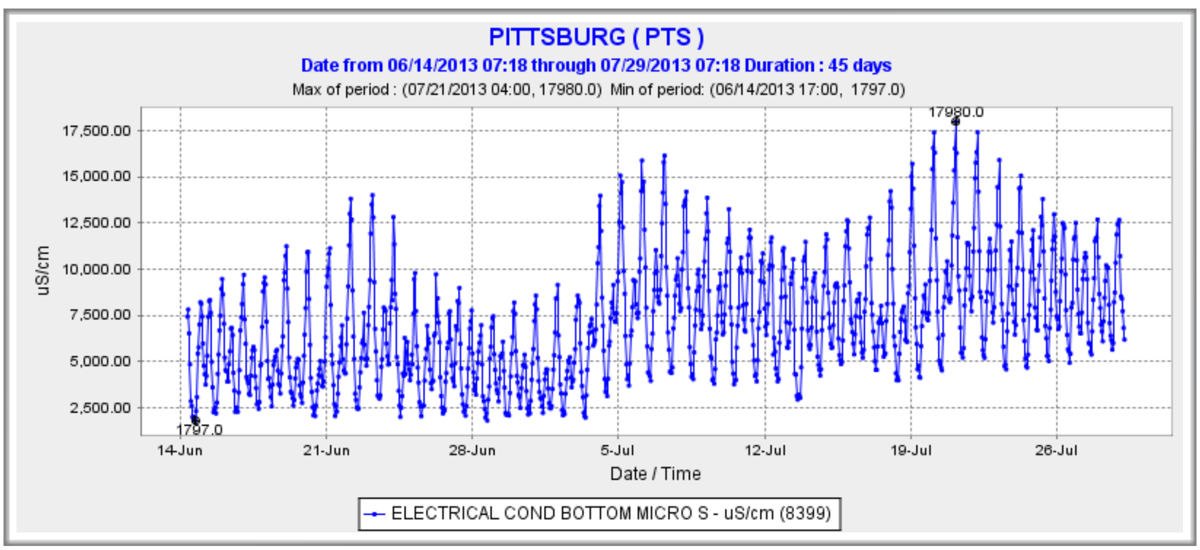


Figure 7. Conductivity (EC) at Pittsburg in Eastern Suisun Bay after mid June 2013. (Source: CDEC)

Central Delta

Central Delta EC as measured Threemile Slough on the San Joaquin River (Figure 8) and False River (Figure 9) also shows the movement of the LSZ upstream coincident with the reduction in Delta outflow at the beginning of July.

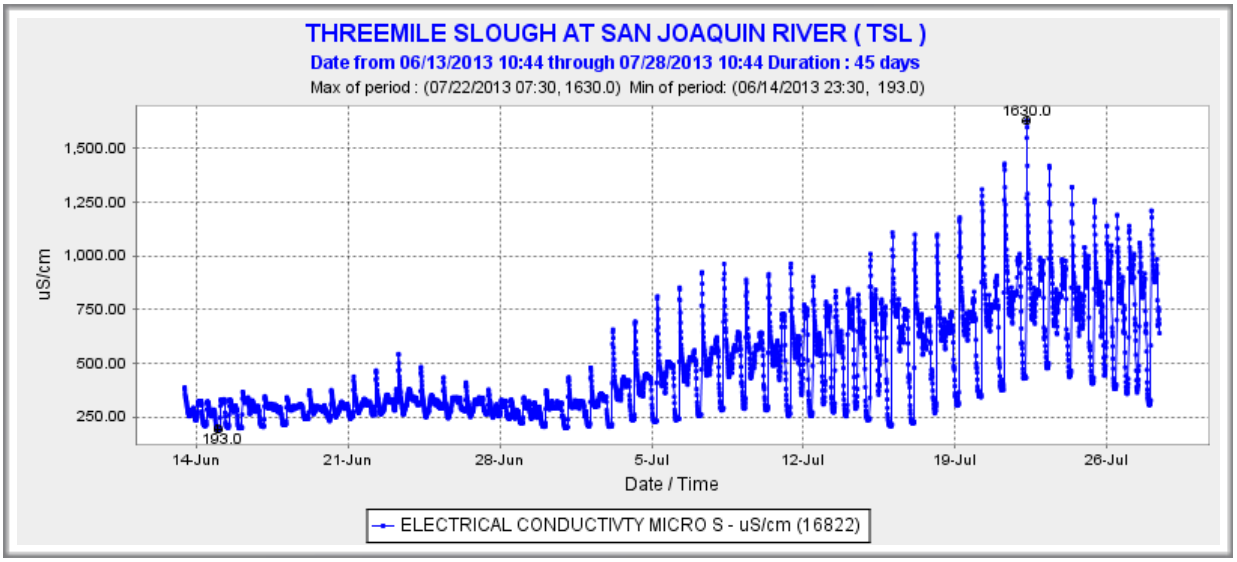


Figure 8. Conductivity (EC) at Threemile Slough in the Central Delta after mid June 2013. (Source: CDEC)

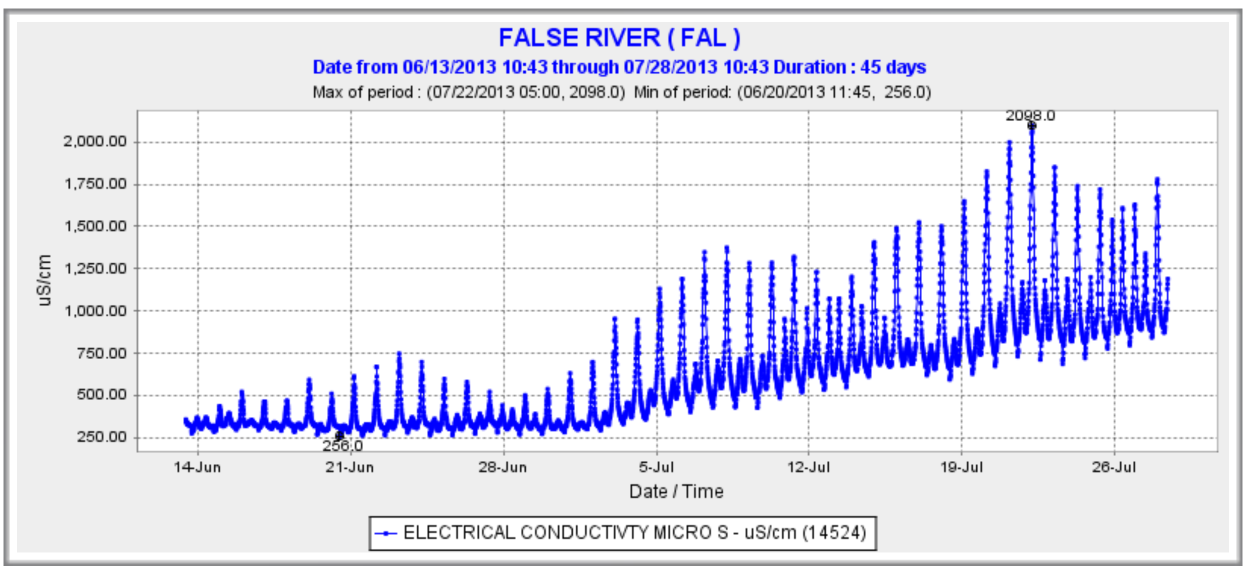


Figure 9. Conductivity (EC) at False River in the Central Delta at Franks Tract after mid June 2013. (Source: CDEC)

South Delta

South Delta EC also increased as the upper portion of the LSZ was mixed with cross Delta moving freshwater Sacramento River on the way to the export pumps. Salinity gradually increased in Old River as the head of the LSZ actually moved into the South Delta toward the export pumps (Figure 10).

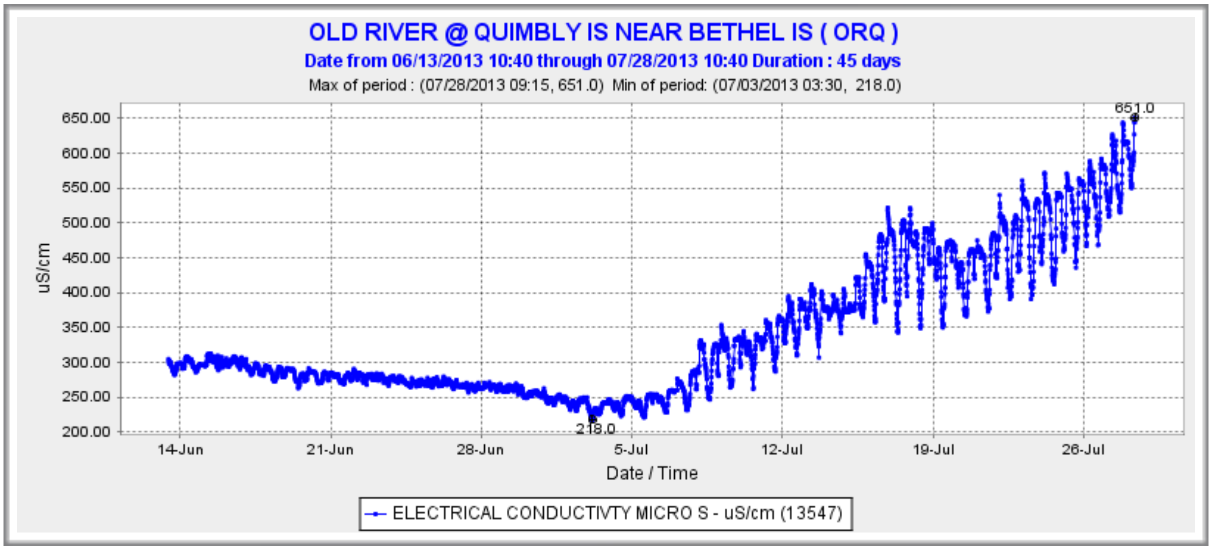


Figure 10. Conductivity (EC) in Old River in the Central Delta near Bethel Is after mid June 2013. (Source: CDEC)

Salinity in Clifton Court Forebay was slightly less as Forebay water is a mixture of Old River, Middle River, and East Delta waters of lower salinity (Figure11).

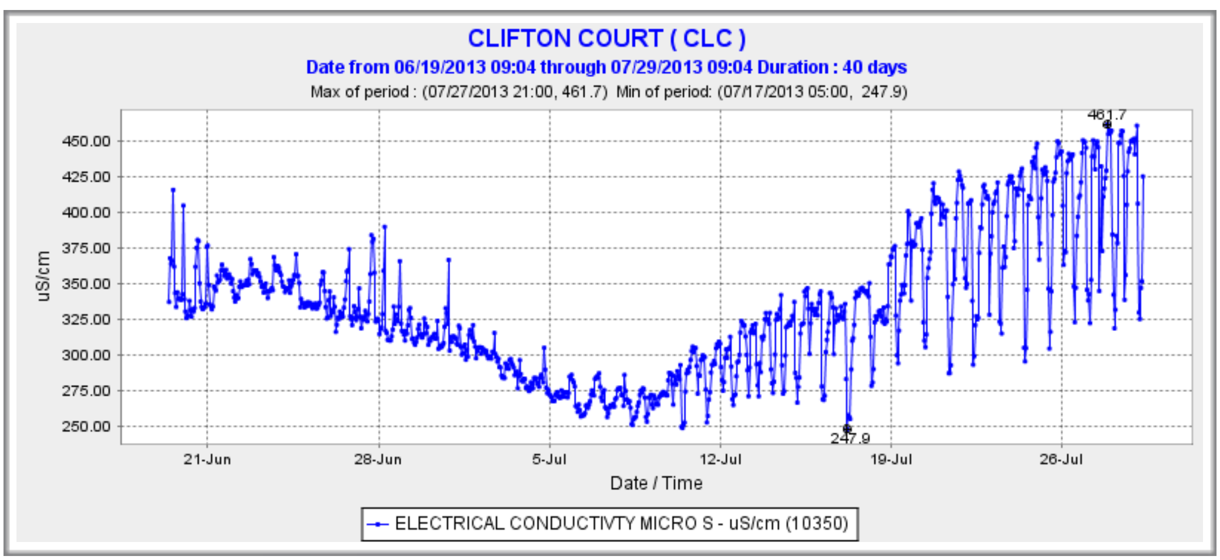


Figure 11. Conductivity (EC) in Clifton Court Forebay after mid June 2013. (Source: CDEC)

Summer Water Temperatures

Western Delta

Water temperatures reached near lethal levels for smelt (75-77F) in the western Delta by the beginning of July (Figures 12-14). Water temperatures rose sharply in late June due to the combination of warm air temperatures and sharply higher Delta inflows. Water temperatures declined thereafter through mid July with lower air temperatures, lower Delta inflows, and cooler waters moving upstream from Suisun Bay with lower outflows.

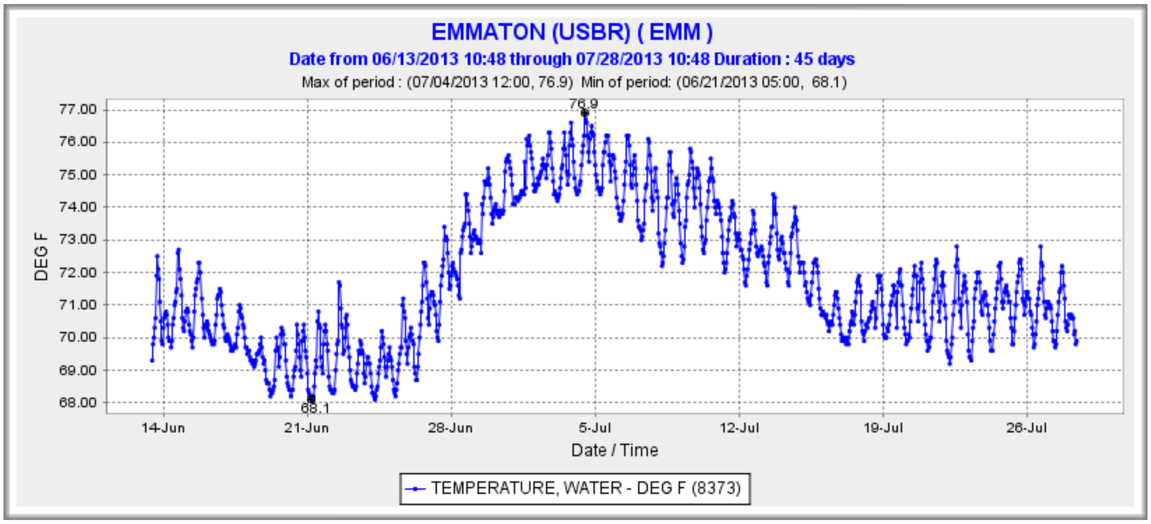


Figure 12. Water temperature at Emmaton mid June through July 2013. (Source: CDEC)

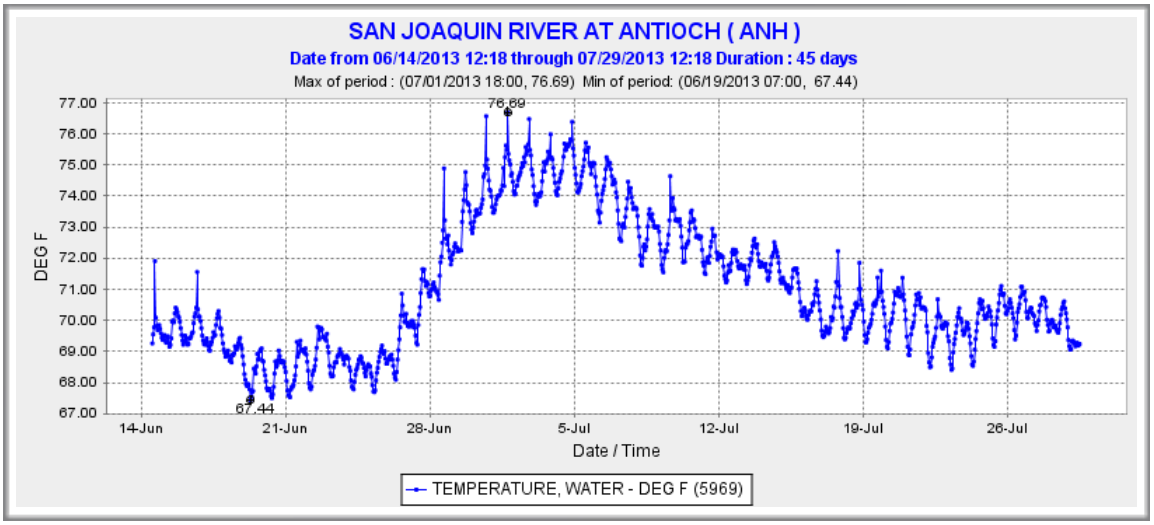


Figure 13. Water temperature at Antioch mid June through July 2013. (Source: CDEC)

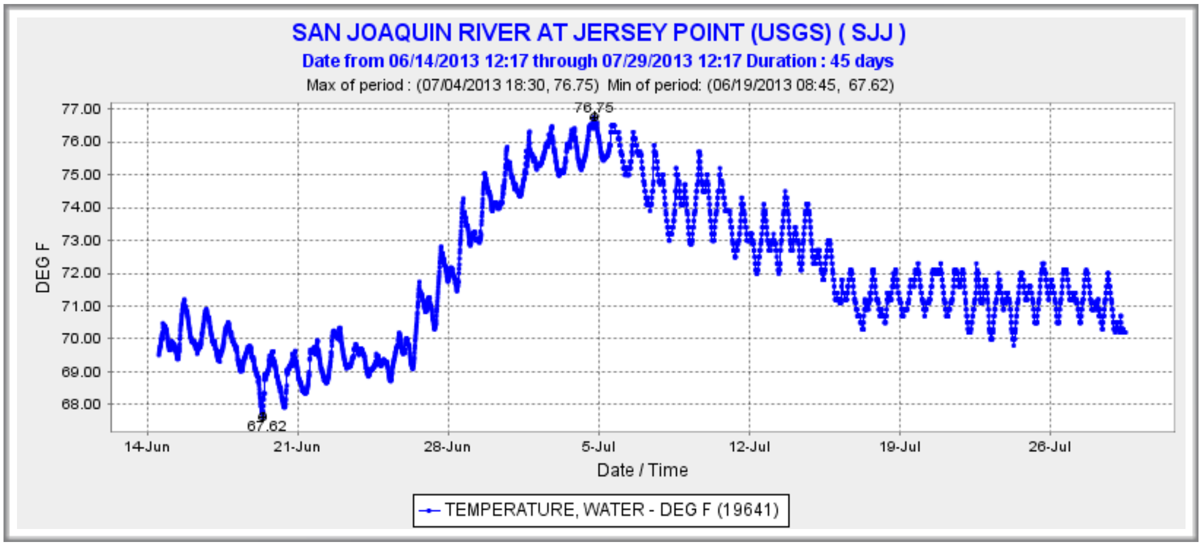


Figure 14. Water temperature at Jersey Point mid June through July 2013. (Source: CDEC)

Central Delta

Water temperatures reached near lethal levels for smelt (75-77F) in the Central Delta by the beginning of July (Figures 15 and 16). Water temperatures rose sharply in late June due to the combination of warm air temperatures and sharply higher Delta inflows. Water temperatures declined thereafter through mid July with lower air temperatures, lower Delta inflows, and cooler waters moving upstream from The West Delta with lower outflows.

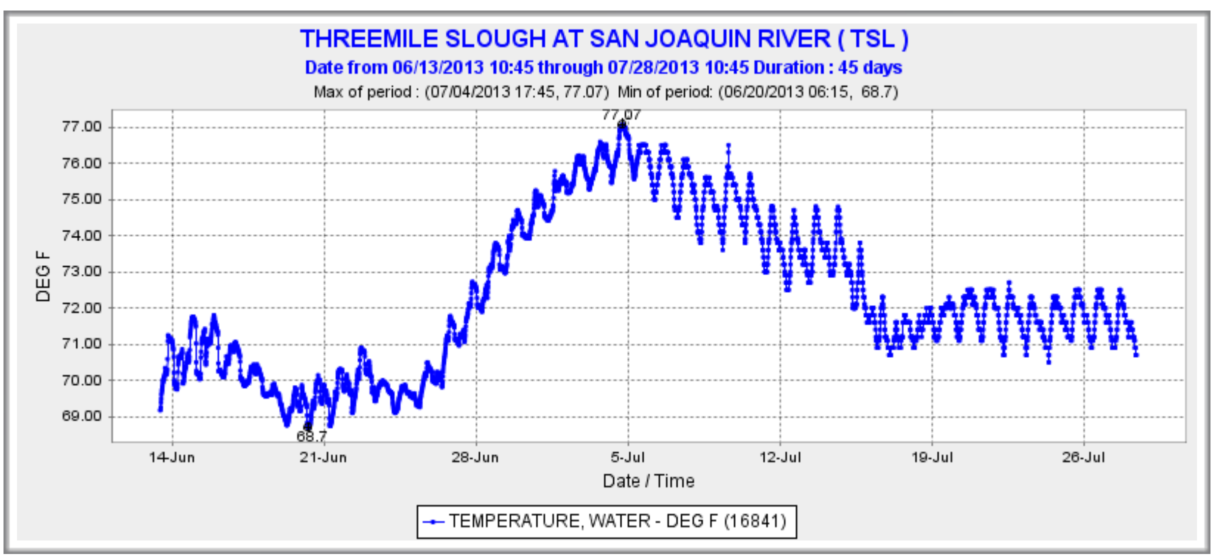


Figure 15. Water temperature at Threemile Slough mid June through July 2013. (Source: CDEC)

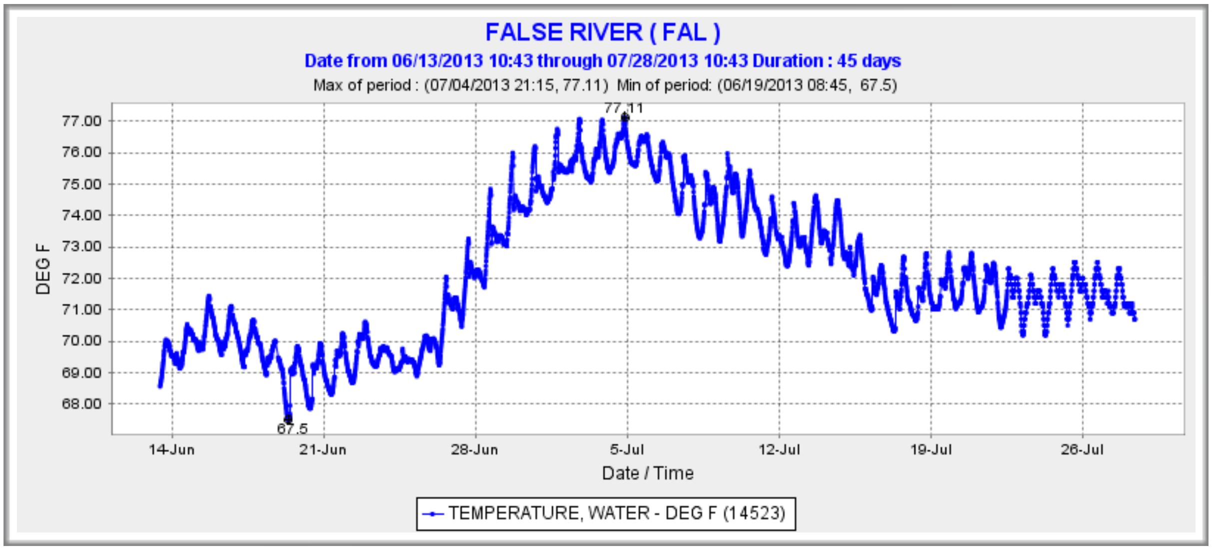


Figure 16. Water temperature at False River mid June through July 2013. (Source: CDEC)

South Delta

Water temperatures reached lethal levels for smelt (78-80F) in the South Delta by the beginning of July (Figures 17-18). Water temperatures rose sharply in late June due to the combination of warm air temperatures, sharply higher Delta inflows, and higher exports drawing warm water into the South Delta. Water temperatures declined thereafter through mid July with lower air temperatures, lower Delta inflows, and cooler waters moving into the South Delta from the western and central Delta with lower outflows.

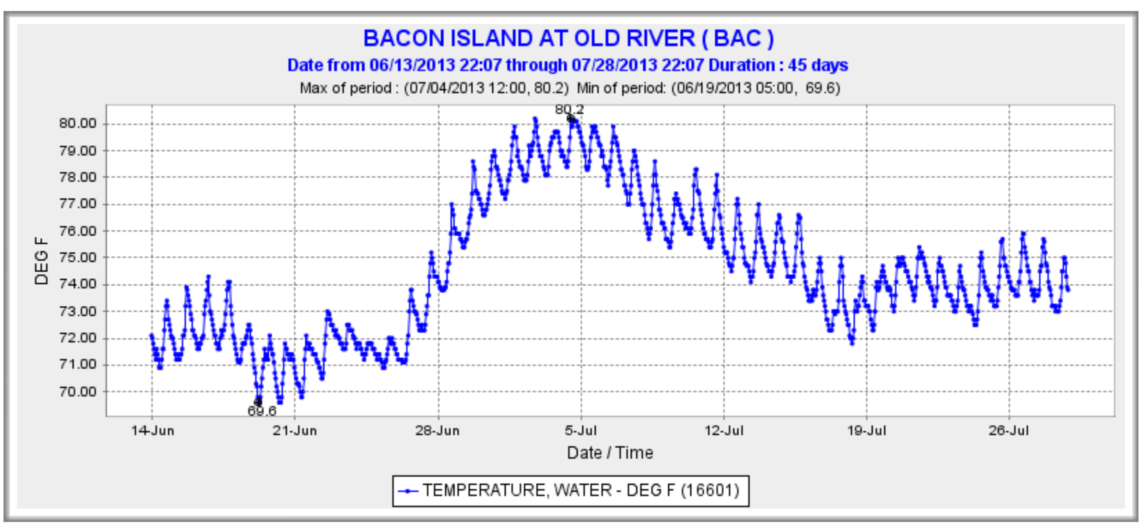


Figure 17. Water temperature in Old River near Bacon Is mid June through July 2013. (Source: CDEC)

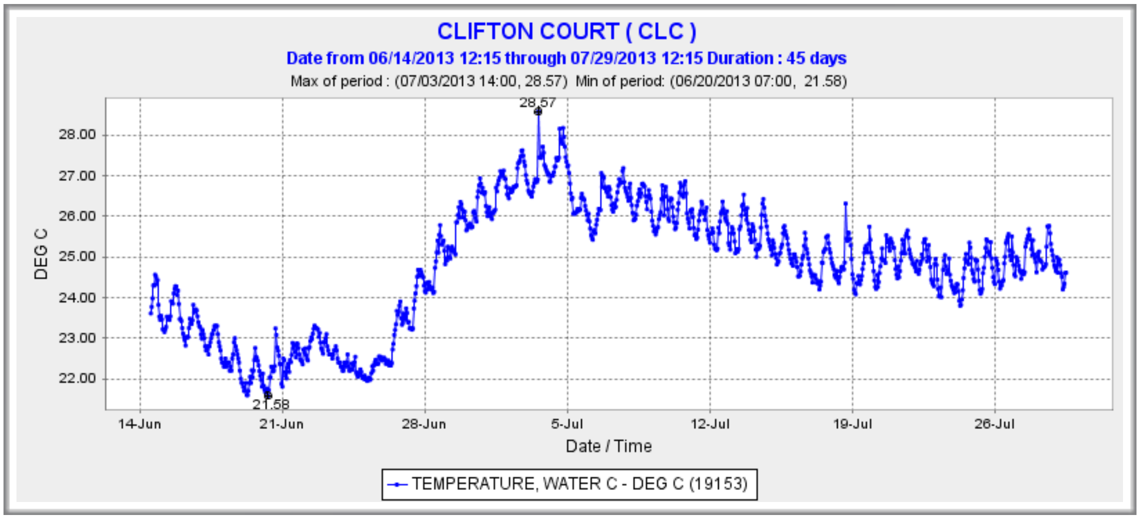
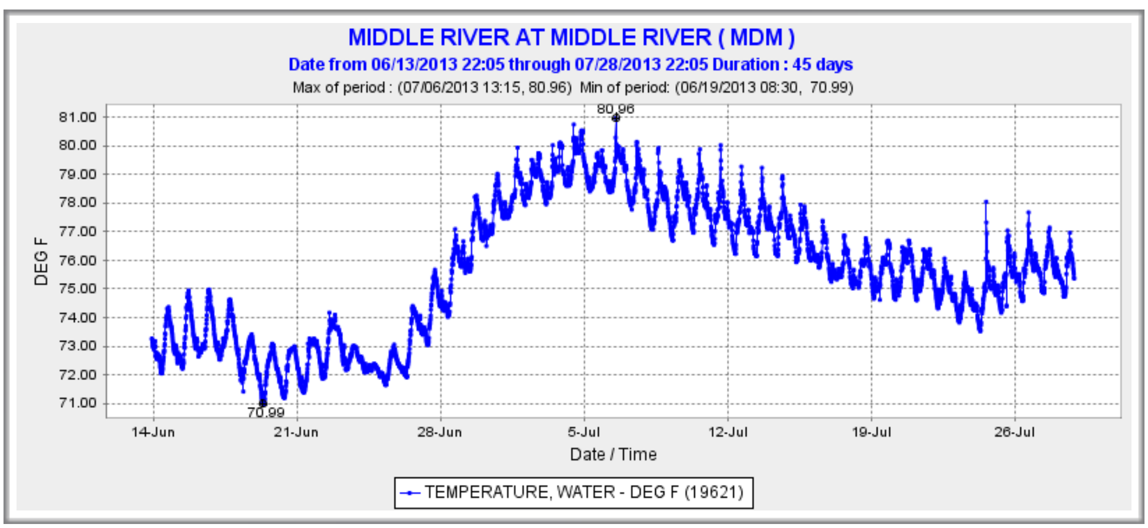


Figure 18. Water temperature in Clifton Court Forebay near Byron mid June through July 2013. (Source: CDEC)

Eastern Delta

Water temperatures in the eastern Delta also reached lethal levels of 80-81F (Figures 19 and 20).

Figure 19. Water temperature in Middle River mid June through July 2013. (Source: CDEC)



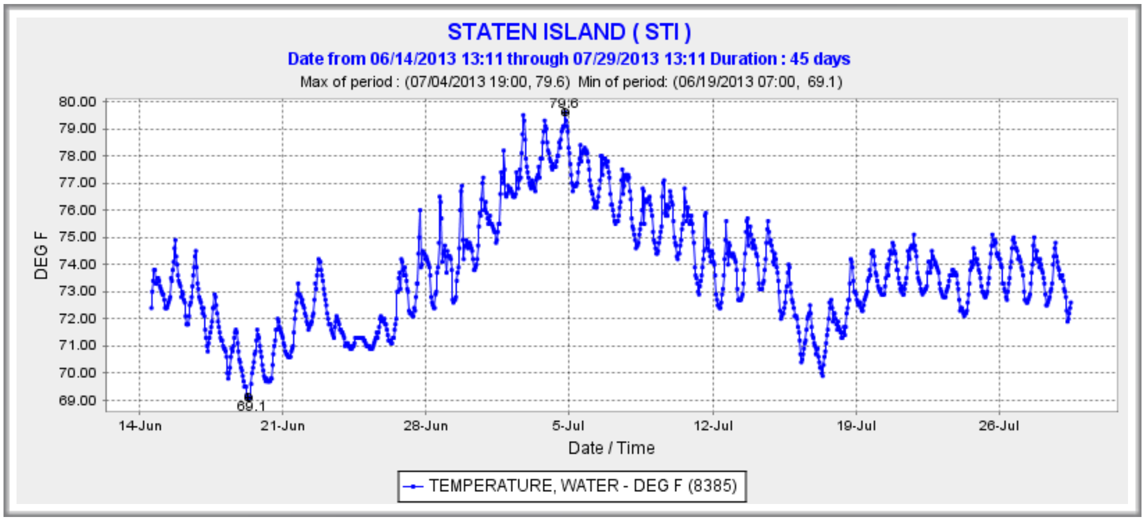


Figure 20. Water temperature near Staten Island mid June through July 2013. (Source: CDEC)

Delta Smelt Vulnerable

With the LSZ reaching into the Central and South Delta at high tides at a greater frequency through July than in wetter years it begs the question as to why were not more smelt salvaged. Clearly small salvage events occurred through mid June coincident with small pulses of exports (Figure 21). But, why not after mid June?

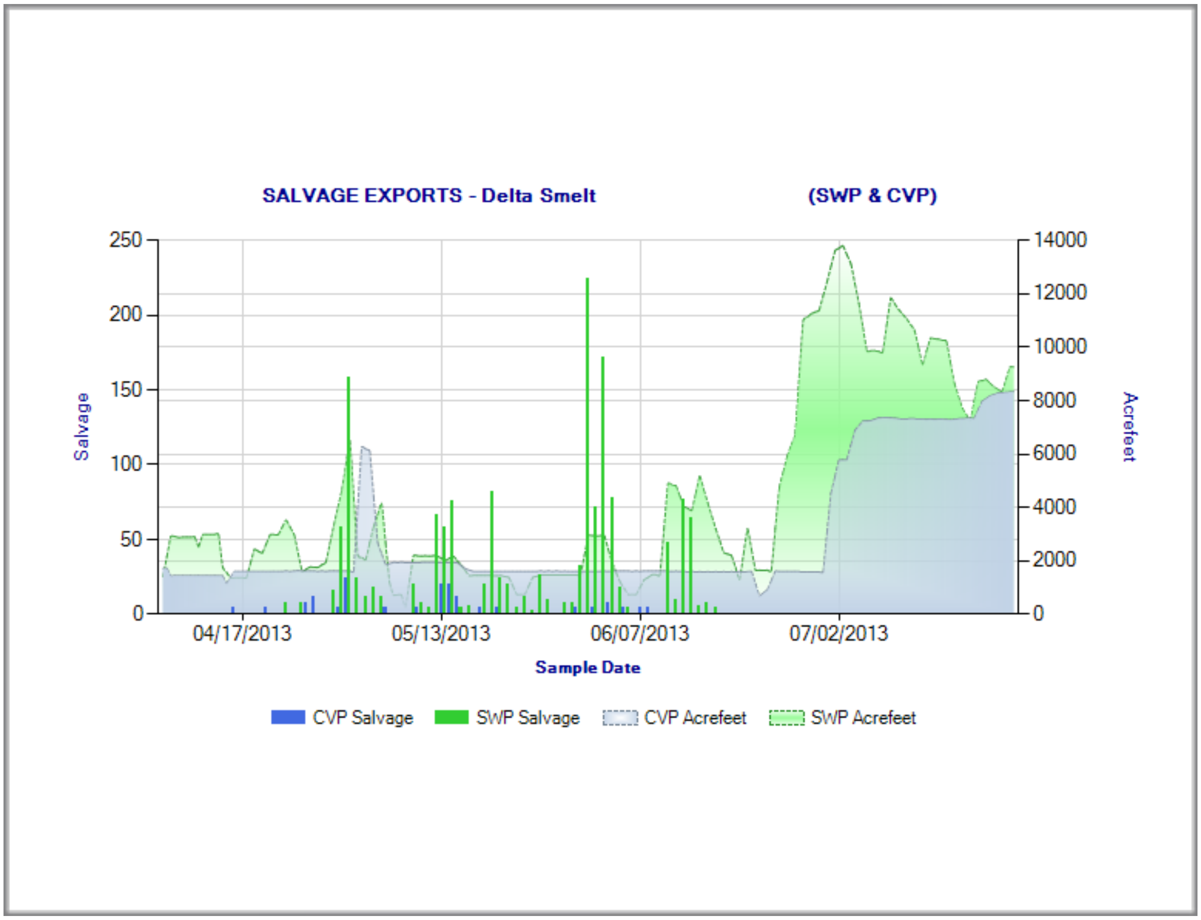


Figure 21. Delta exports and smelt salvage In spring and summer 2013. (Source: USBR MP)

First, the high inflows, low exports and high outflows kept the LSZ away from the influence of the pumps toward the end of June. Until about 8 July export demand was satiated by the pool of freshwater left over in the Delta from prior high inflows as observed in Clifton Court Forebay EC (Figure 11). But soon thereafter evidence of the LSZ being drawn to the pumps was apparent.

So why were no smelt salvaged after exports picked up and the LSZ entered the Central Delta? The answer is high water temperatures by early July. No smelt were able to survive passage to the

South Delta export salvage facilities because of lethal water temperatures in the Central and South Delta.

The high exports and high inflows at the end of June and beginning of July not only pulled the LSZ upstream into the Central Delta and under influence of the South Delta pumps at Clifton Court Forebay, but it also lead to a sharp increase in water temperature throughout much of the LSZ that was lethal to delta smelt (77-80F or 25-27C). Warm weather occurred at the beginning of July throughout the Delta (but reaching over 100F to the north and east), along with nearly a week of 20,000 cfs inflow (from the north and east) with high ambient water temperature, and near 10,000 cfs exports resulted in near lethal or lethal water temperatures in the North, Central, West, and South Delta. Smelt were able to survive only in the western portion of the LSZ of eastern Suisun Bay and extreme western Delta (Figure 22) where water temperatures remained sub-lethal at 22-24C.

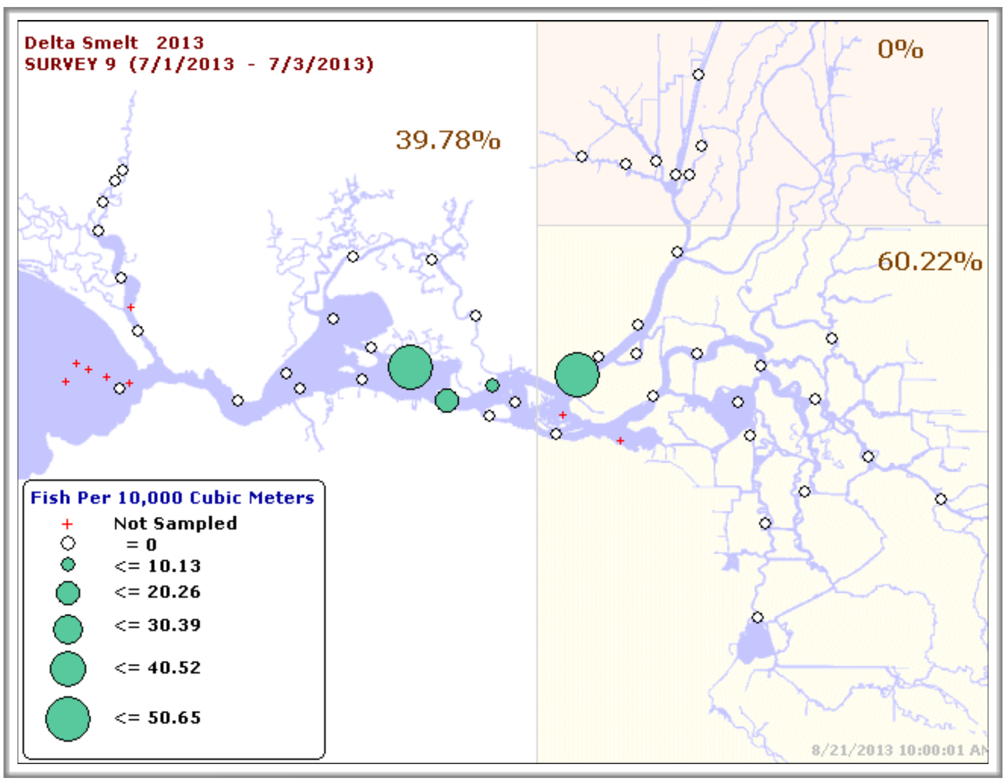


Figure 22. Early July 20-mm Smelt Survey results. (Source: http://www.dfg.ca.gov/delta/data/20mm/)

This ninth and last of the Department of Fish and Wildlife's 2013 20-mm Survey shows that the majority of smelt were in the Delta at the beginning of July. The Summer Townet Survey that began in mid June (unpublished CDFW data) has provided a Delta smelt abundance index based upon its first two surveys (weeks of June 10 and 24). The preliminary 2013 index is 0.7, down from last year's 0.9. The results from the remaining Summer Townet Survey and the Fall Mid-

Water Trawl Survey will help reveal the full extent to which Delta smelt were harmed by Project operations this summer. Based upon my decades of experience, I suspect that summer 2013 parallels the conditions during the Pelagic Organism Decline (POD) and record low smelt indices early in the last decade.

Solution

The problem remains that neither the D-1641 Water Quality Objectives for the Delta or the OCAP Biological Opinions have protections for Delta smelt after June. The demise of VAMP's limit on exports in the late spring has exacerbated the problem. The D-1641 dry and critical year standards for outflow are simply too low to protect delta smelt and their important habitats. Even with higher outflows, excessive exports remain a problem. The inflows necessary to sustain high exports reduce reservoir storage and cold-water pools, and bring warmer, low-productive reservoir water into the Delta and LSZ. Cooler, more productive, more turbid water, critical to delta smelt growth and survival is first exported from the Delta and then replaced with warm, low turbidity, low productivity reservoir water. Higher summer outflow and reduced exports (and a minimum of inflow necessary to sustain reduced exports) in drier years are fundamentally necessary for delta smelt recovery. A minimum of inflow and exports will increase residence time and productivity, allow higher productivity waters and smelt to remain in the Delta, and allow Delta waters to remain cooler to sustain smelt.